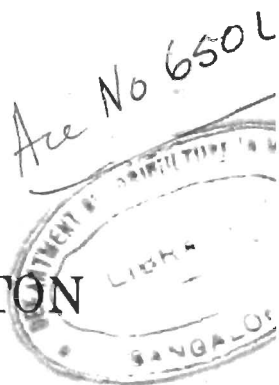


INDIAN CENTRAL COTTON COMMITTEE



INSECT PESTS OF COTTON IN INDIA

BY

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COTTON CROP IN INDIA

India is the second largest cotton growing country in the world, being next only to the United States of America. Out of a total cultivated area of about 350 million acres in this country, about 24 million acres, or roughly 7 per cent, are annually devoted to this crop, from which, on the average, a yield of 5.5 million bales (400 lbs. each) of cotton is obtained. Cotton is cultivated in almost all the Provinces and States but it is most extensively grown in those areas where the annual rainfall is less than 50". Table I shows the area and total production of cotton in different Provinces and States:—

TABLE I

*Estimated area and total production of cotton in different
Provinces and States of India*

(Average for 5 years: 1936-37 to 1940-41)

Name of Province or State	Area in thousands of acres	Percentage of total cotton area in India	Production of cotton (000 bales of 400 lbs. each)
Bombay	5,745	24.0	1,070
Central Provinces and Berar	3,837	15.5	738
Punjab	3,606	15.4	1,551
Madras	2,329	9.8	466
United Provinces	673	2.4	171
Sind	963	4.0	398
Bengal	96	0.4	28
Bihar	40	0.2	7
Orissa	8	..	1
Assam	38	0.1	16
Ajmer-Merwara	28	0.1	16
North-West Frontier Province	20	0.1	3
Delhi	2	..	..
Hyderabad	3,356	14.1	525
Central India	1,210	5.1	171
Baroda	839	3.5	196
Gwalior	605	2.6	88
Rajputana	464	2.0	84
Mysore	85	0.3	12
TOTAL ..	23,694		5,535

Cotton varieties belonging to three species, namely, *G. arboreum* L., *G. herbaceum* L., and *G. hirsutum* L., are cultivated in India. Since the bulk of the cotton crop in this country is grown under rain-fed conditions, the first two species, on account of their greater hardiness and drought resistance, are by far the most extensively cultivated,

while the cultivation of *hirsutum* types is restricted to such areas as have adequate facilities for artificial irrigation. Commercially, the cotton varieties of India are classified into 13 groups according to the tracts in which they are cultivated, and the area and production, etc., of each of these commercial varieties is shown in Table II.

TABLE II

Estimated acreage and yield of different commercial varieties

(Average for 3 years: 1938-39 to 1940-41)

Description	Tract of production	Area in thousands of acres	No. of bales (thousands)
Bengals	Punjab, United Provinces, Sind and Rajputana	2,928	1,042
Americans	Sind, Punjab and Buri	2,470	1,023
Oomras	Central Provinces, Berar, Nimar, Khandesh, Hyderabad	6,591	1,289
Dholleras	Gujarat, Kathiawar and Cutch	1,939	278
Southerns	Kumbla, Bijapur, Bagalkot, Warangal and Cocanadas, etc.	3,392	477
Tinnevellies	Madras	658	147
Cambodias	Madras	403	150
Salerns	Madras	51	5
Comillas	Bengal, etc.	134	44
Gaorani	Hyderabad	881	138
Malvi and others	Central India	1,695	260
Broach	Gujarat and Baroda	864	238
Surti	Surat	652	158

Geographically, India lies between 62° and 97° East longitudes and between 7° and 37° North latitudes and has an area of about 1·8 million square miles. Such a vast country is naturally expected to show a great diversity of climate, rainfall, soil types, etc. In the northern portion, which consists mostly of plants, extremes of temperatures are experienced, while in the southern table land there is hardly any cold weather. The annual rainfall varies from 5·7 inches in Sind to over 200 inches in some places in Assam. Similarly, the soil types range from the barren sandy deserts of Rajputana and Bikaner to rich alluvial loam of the Indo-Gangetic plain in the North and the very fertile black cotton soils of the South. Such diverse conditions must have a profound effect on the agricultural conditions of different localities, causing great variation in the varieties of cotton grown, methods of cultivation followed, and the yields of seed cotton obtained. It is, therefore, difficult to treat the whole of India as a single unit, and a vivid picture of cotton cultivation in different parts of this sub-continent could best be presented by

describing the climatic conditions, soil types, varieties grown, etc., separately for each Province and State. Such a description of the most important cotton growing Provinces and States is given below:—

(1) Sind

The cotton growing area of Sind may be divided into three tracts, viz., (i) South-East, (ii) Middle Sind and (iii) North Sind. The first two tracts are situated on the left bank of river Indus and the third on the right bank. The climate of these tracts is fairly hot in summer, the maximum temperatures ranging from 100°–110° F., and very cold in winter. The rainfall is generally very low (5–8 inches). The soil types met with in Sind range from light sandy to very hard clay, but majority of them are fairly fertile and productive. Climatically, the South Eastern Sind differs from other two tracts in having comparatively lower temperatures, greater rainfall and higher rate of wind velocity. The Right Bank area is similar to the Middle Sind tract on the Left Bank except that the nights are close in the former area as compared to the cool breeze prevailing at night and a brisk wind during day on the Left Bank.

Cultivation of Cotton.—The whole of the cotton crop is sown under irrigation provided by an extensive network of canals taken out from the Indus. The sowing time of the crop is from 15th March to 15th May. The preparatory tillage given to the crop is very poor but more intertillage is done. Seed rate used is 20–30 lbs. per acre. The harvesting season starts in the end of September and continues till the end of December, but may extend to January if frost does not occur.

Varieties.—Two main types of cotton, viz., American (*G. hirsutum*) and *desi* (*G. arboreum* L. var. *neglectum* forma *bengalensis*) are cultivated in Sind. The most important strains of the former being Sind *Sudhar* (289F–1) with a staple length of about 1" and 32s spinning capacity, and Sind 4F (4F–98) which has a lint length of 15/16" and is particularly suitable for the cotton area on the Right Bank of Indus. Among the improved *desi* strains, 27 W.N. which surpasses the local *desi* cotton in yield is extensively cultivated. The chief feature of this cotton is extreme shortness and roughness of staple and it commanded a very good price in the Continental markets especially Italy. Some Egyptian and Sea Island cottons had also been introduced in the Province but so far no variety of these cottons has been established on any extensive area.

Pests.—The most important pests of cotton in Sind are jassid, spotted bollworm and black-headed cricket. Jassid is most prevalent in the South-East of Tharparkar district, while Black-headed Cricket is a serious pest in the seedling stage in the Khirtar and Johi tracts

near the border of Baluchistan. Spotted bollworm is of general occurrence in the Province and causes a great deal of damage.

Amongst the important diseases of cotton in Sind, Red-leaf disease and root rot may be mentioned. The former is prevalent only in the American varieties.

(2) Punjab

Of the five ecological regions into which this Province can be divided, namely, Canal Colonies tract, South-Western tract, South-Eastern tract, Sub-montane tract and the Hilly tract, cotton crop is most important in the first three, only of very minor importance in the fourth, while it is not at all cultivated in the fifth region. The Soil types of the cotton growing tracts vary from sandy loam to clay loam of alluvial origin, but at some places in the Montgomery district, highly saline soils (locally called *Bara* lands) are met with. These, however, are not used for cotton cultivation. The climate of all the three cotton growing tracts is very severe, the summer temperatures rising to about 118° F. in June while the winters are fairly cold and frosty. The average annual rainfall varies from 10-15" in the Colony districts, 6-10" in the South-Western Punjab and 15-32" in the South-Eastern tract.

Cultivation of Cotton.—About 95% of the total cotton crop in the Punjab is sown on irrigated lands and only 5% *barani* (rain-fed). The sowing time varies from beginning of April to end of June in different regions, it being earliest in the South-Eastern tract and latest in the South-Western districts, where the sowings have often to be done by irrigation from inundation canals which begin running somewhere in June. The crop is mostly sown broadcast, but line sowing with the help of drill or country plough is becoming increasingly popular. Seed rate of 8-12 lbs. in *desi* cotton and 12-16 lbs. in American is generally used. The preparatory tillage consists of 3-6 ploughings given with the country plough according to rotation followed and the time available between the harvesting of the previous crop and the sowing of cotton. The intertillage consists of 2-3 hoeings given mostly with the country plough. The crop receives 5-8 irrigations throughout its growth period, depending upon the weather and amount of rainfall. American cottons, as a rule, receive more irrigations than *desi*. The picking season of the crop extends from the end of September to the beginning of January, the number of pickings taken being 6-8 in *desi* cottons and 3-4 in Americans.

Varieties.—Several varieties of both *G. arboreum* and *G. hirsutum* L. are cultivated in the Province. The former has two distinct types, one with green plant body and white flowers (*Mollisoni*) and the other with red plant body and pink purple flowers (*sanguineum*). The

Mollisoni types are grown in the whole of the Province excepting South-Western districts in which *Sanguineum* types are very largely cultivated. The area under *hirsutum* cottons is concentrated exclusively in the Canal Colony districts and South-Western tract, and formed about 53% of the total area under cotton in the Province during 1940-41.

As for the varieties of *desi* and American cottons introduced by the local Department of Agriculture, *Mollisoni* 39, *Mollisoni* 60 A₂, 119 *Sanguineum*, 12 *Sanguineum* are the most important strains of the former and 4F, L.S.S., 289F/43 and 289F/K. 25 of the latter. Most of these types have been bred to suit different tracts and have, consequently, a well marked regional distribution. The lint length of *desi* types is usually $\frac{5}{8}$ " and less, and their ginning outturn varies from 35-40%. These are all classed by trade as short stapled under the name "Bengals". The lint length of American varieties varies from $\frac{7}{8}$ " to full 1" while their ginning outturn ranges from 29-35%. With the exception of 4F, which is classed by trade as medium stapled, the rest of the American varieties are included in the long stapled group.

Pests and Diseases.—The most important pests of the cotton crop in the Punjab are bollworm, jassid and white-fly. Both the spotted and pink bollworms are met with, the former attacking mostly the *desi* cottons and the latter the American cottons. In the South-Eastern tract, however, pink bollworm is the chief pest of *desi* cottons also. *Empoasca devastans*, Dist. is the most prevalent species of jassids but several other species have also been recently identified. This pest attacks only the American cottons. White-fly (*Bemisia gossypiperda*) predominates mostly in the Canal Colony districts of the Province and attacks *desi* and American cottons alike.

Among the various diseases attacking cotton, root rot caused by *Rhizoctonia* sp. is the most important. A physiological derangement, called *tirak*, causing bad opening of bolls in American varieties, has assumed serious proportions recently. The incidence of this is heaviest on poor and alkaline soils.

(3) United Provinces

Climate.—Like Punjab, this province too has extremes of climate, the summer temperatures rising to about 112° F. in June, while the minimum temperatures in December and January may go so low as freezing point in the Western districts. The rainfall varies from 15-20" in the Western tract to about 35" in the Central and Bundelkhand tracts. The main soil types on which cotton is sown in this province are of Gangetic alluvial origin.

Cultivation of Cotton.—The cotton crop in the Bundelkhand, Rohilkhand and Central United Provinces is mostly sown under rain-

fed conditions, but about $\frac{2}{3}$ of the crop in the Western parts of the province is sown with irrigation. Sowings commence in May on irrigated soils and in June under rain-fed conditions. The preparatory tillage consists of about 4 ploughings given with the country plough. The bulk of the crop is sown broadcast, but line sowing is being increasingly resorted to on the recommendation of the local Agricultural Department. A seed rate of about 12 lbs. per acre is used. The after-tillage consists of 3-4 weedings and hoeings. The picking of the crop starts in about the second week of September. About 6-7 pickings are usually taken in the *arborescens* cottons, while in *hirsutum* 3-4 pickings are sufficient to bring in the whole crop.

Varieties.—The crop comprises mainly of U.P. Bengals (*G. arborescens* var. *neglectum* forma *bengalensis* H. & G.), but recently a *hirsutum* variety, *Perso-American*, has been introduced in the Western part of the province with considerable success. Of the *desi* varieties grown in the province, C. 520—a strain evolved by the local Agricultural Department is the most important and was grown on an area of 32,000 acres during 1940-41. The lint length of C. 520 is 0.76" and this type spins 12.5s counts, while *Perso-American* has a lint length of 0.88" and spins 31s counts.

Yield.—The average yield of irrigated cottons is about 650 lbs. and of unirrigated about 400-450 lbs. per acre. The yields are slightly lower in the Rohilkhand and Central parts of the United Provinces than in other tracts.

Pests and Diseases.—Leaf-roller and pink bollworm are the main insect pests attacking cotton in this province, while among the fungal diseases, wilt (*Fusarium* sp.) does some damage to the *desi* crop.

(4) Central India

This part of India can be divided into two distinct ecological regions: (i) the Malwa plateau with an average rainfall of 33" and (ii) the Nimar tract with rainfall not more than 20-25". The soil of both the tracts is classed as black cotton soil, but the extreme northern portion of the tract merges into sandy soils of Rajputana on the North-West and the alluvial soils of United Provinces on the North-East. Portions of Central India in the North-East (Bundelkhand States) have rich alluvial soils.

Cultivation of Cotton.—The cotton crop in Central India is mainly a rain-fed crop, although a small percentage of it, 4-8%, is irrigated from tanks and wells. The sowing of the crop starts with the break of south-west monsoon in June and may extend up to the first week of July. The only preparatory tillage given for cotton sowing consists in using the blade harrow 2-3 times before the monsoon breaks. Sowing is always done in lines with local drills or with a bamboo tube

attached behind the country plough. Spacing between lines is about 14". Seed rate used is 25-30 lbs. per acre. The after tillage consists of passing the bullock harrow once or twice between cotton rows. Sometimes no tillage is possible on account of continuous wet weather. The picking of crop starts by the middle of November, unless it gets delayed by late rains. The whole crop is usually picked in three pickings.

Varieties.—The cotton grown in each ecological region is named after the name of the tract, that in Malva plateau being called 'Malvi' and the one grown in Nimar tract being called 'Nimari'. The *Malvi* cotton is a mixture of *G. arboreum* var. *neglectum* and *G. hirsutum*, the proportion of the latter varying from 20-80%. The price offered by the trade for *Malvi* cotton depends on the proportion of the *G. hirsutum* component, the one containing higher proportions of this species getting a better price.

The *Nimari* cotton is generally a poorer cotton in quality as compared to *Malvi*, but is slightly higher ginning. Botanically it is grouped under *G. arboreum* var. *neglectum* but the crop is a heterogeneous mixture containing plants of varying leaf shapes and different flower colours, the roseum type (narrow lobed leaf and white flower) generally predominating.

Both *Malvi* and *Nimari* cottons come under the trade name "Oomras".

Yield.—The yield of cotton in this tract varies according to the depth of the soil. In deep fertile soils with normal rainfall, yields of 600-800 lbs. of *kapas* (200-270 lbs. lint) are not rare. In very shallow soils the yield of *kapas* may be as low as 100-150 lbs. only. In rich irrigated lands, yields of 800-1,200 lbs. of *kapas* are quite commonly obtained.

Diseases and Pests.—Among the various insects attacking cotton in this tract, only bollworm is of some importance, though it is not a serious pest except in pure American cotton crop. The incidence of shoot borers is sometimes heavy in the earlier stages of the crop, but the ill-effects of this pest are soon got over by increased branching and the yields are not seriously impaired.

Under diseases, cotton wilt (*Fusarium* sp.) has appeared recently in the tract and is assuming importance gradually, devastating mainly the *desi* cottons. The American cotton suffers both from red leaf disease and leaf roll, the incidence of these diseases mainly depending on the amount of rainfall. Symptoms of both these diseases appear a week or 10 days after the cessation of rains.

(5) Central Provinces and Berar

The main cotton growing tract in Central Provinces consists of Nagpur plains, with broad stretches of "deep" black cotton soils and

about 40–45" rainfall. Berar, which lies to the South-West of Central Provinces, also has similar type of soil and is the most important cotton growing country, the area under cotton in this tract being 40% of the total cultivated area as compared to 6% in Central Provinces. The average annual rainfall of Akola—the centre of cotton cultivation in Berar—is about 30".

Cultivation of Cotton.—Practically the whole of the cotton crop in Central Provinces and Berar is grown on rains. Sowings commence in June, while the pickings start towards the middle of October and are over in December. The land for sowing cotton is rarely ploughed and is simply scratched with a blade harrow (*bhakkar*). Sowing is done in lines by means of a wooden drill.

Varieties.—The cotton produced in the Central Provinces and Berar is commercially known as "Oomras", the annual output of which amounts roughly to one-seventh of India's total production of cotton. Prior to 1923, the bulk of this crop was of the shortest and coarsest staple capable of spinning 8s to 10s counts only, but these have gradually been replaced by improved *Verum* types, chief among which now holding the field is V. 434 with a staple of $\frac{7}{8}$ " and 32s–37s spinning capacity. *Jarila* cotton bred in Khandesh (Bombay) has also been found to be suitable for cultivation in Berar and is spreading there on its own merits. In the Burhanpur tehsil of Nimar district, Buri 107, an improved upland variety (*G. hirsutum*), is being introduced successfully.

Pests and Diseases.—The only pest of any importance is the spotted bollworm.

(6) Baroda State

The State consists of 4 distinct cotton growing tracts: (i) lying south of Narbada with medium alluvial loam soils and 40–50" rainfall, (ii) lying between Narbada and Sabarmati with heavy alluvial to light alluvial loam soils and about 36" rainfall, (iii) North Gujarat where the soils are of sandy alluvial type and the rainfall varies between 22–25", and (iv) some areas in Kathiawar in which black cotton soils overlying rock at about 1½'–2½' depth are met with and the rainfall is about 16–18". Cotton crop is fairly important in all these four tracts.

Cultivation of Cotton.—Practically the whole of cotton crop is sown under rain-fed conditions. Time of sowing of the crop falls in June–July. The crop is sown in lines by means of a drill. A distance of 4'–6' between rows of the crop is allowed in the first three ecological regions named above, while the spacing followed in the fourth region is 15–30". A seed rate of 7–12 lbs. per acre is used. The preparatory

tillage in the first two regions and the last is chiefly done with a blade harrow, but from time to time deep ploughing is also done. In the third region, preliminary tillage is done chiefly with the help of the country plough. Intertillage is done 3-4 times using either a small blade hoe or a tine cultivator. The picking time of the crop varies in the different regions, it being February, March and April in the first three tracts and November-December in the fourth.

Varieties.—The varieties of cotton cultivated in Baroda also vary with the region. In the tract lying south of Narbada, the entire crop consists of *G. herbaceum*, the chief variety grown being 1027 A.L.F. The cotton crop in the tract between Narbada and Sabarmati is very largely ordinary Broach but now the Agricultural Department recommends the varieties B.D. 8 and B. 9. In North Gujerat, "Dholleras" are being cultivated, 70% of the total area being under Wagad varieties and the balance under inferior Broach. The Agricultural Department of the State is concentrating on the variety Wagad 8, of which there are at present 7,000 acres. In the Kathiawar areas, the short staple *Mathio* cotton is cultivated for the most part. In one taluka of this tract on the seacoast, cotton sown is a mixture of 60% *G. hirsutum* and 40% *Mathio*. The Department of Agriculture in the State is meeting with great success in introducing the *desi* variety, C. 520 from United Provinces and the American variety 289F/43 from Punjab in this tract.

Yield.—The average yield of cotton varies from 120-320 lbs. in different regions, highest yields being obtained in the tract lying between Narbada and Sabarmati and the lowest in Kathiawar.

Pests and Diseases.—The most important insect pest attacking cotton in Baroda State is spotted bollworm. Amongst the fungal diseases, root rot is of importance in parts of Baroda State. A variety of cotton, called *Karkhadi* is supposed to be partially resistant to this disease.

(7) Bombay

There are seven important cotton growing tracts in the Province, viz., the Kumpta-Dharwar, Bijapur and Bagalkot Jowari, Barsi Nagar, Khandesh, Surti, Broach and Dholleras tracts. The soil of these tracts varies from sandy loam (locally called Gorat) and clay loam with a fair content of lime in North Gujerat to black cotton soils of varying depth, texture and colour in the Deccan, Karnatak and Khandesh. The rainfall of these tracts also varies a good deal, it being 18-25" in North Gujerat to about 40" in Surat and 33" in Dharwar.

Cultivation of Cotton.—The cotton crop in Bombay is mostly sown under rain-fed conditions. The sowing time varies in the different tracts, in Khandesh-Deccan tract, *Kharif* (Autumn harvested) crop being cultivated, while in Gujerat and Karnatak *Rabi* (spring harvested)

sowings are generally done. The preparatory tillage given to the crop varies from 2-3 harrowings and the sowing is generally done with a seed drill in rows 18" apart with a seed rate of 12-20 lbs. per acre. The after tillage consists of 5-6 interculturalures and one or two hand weedings. The number of pickings taken from the crop is generally three but in the case of Wagad which opens its bolls only partially, the whole bolls are plucked from the plant once and their cotton is extracted later on at leisure.

Varieties.—The varieties of cotton cultivated in Bombay also vary with the tract. In Kumpta Dharwar region, two improved strains, viz., Jayawant (*G. herbaceum* var. *frutescens* Delile) for the Kumpta tract and Gadag 1 (*G. hirsutum* L.) for the Dharwar American tract, have been introduced by the local Agricultural Department to replace *desi* or Surti local and the local upland respectively. Jayawant has a staple of 15/16" and a ginning outturn of 28% and is capable of spinning 26s-30s counts as against 22s of the local. This cotton is also partly replacing the short staple cotton of Bijapur and Bagalkot Jowari tract. Gadag 1, with a staple length of $\frac{7}{8}$ " and 33% ginning outturn spins 24s-30s counts against 18s of the local upland. In Barsinagar tract and Khandesh, *Jarila* cotton, with medium staple and spinning capacity up to 24s counts against 10s-12s of the local mixture, has spread on an area of more than 6 lakhs acres out of a total of 11 lakhs. In the Surti tract of Bombay Province, *Goghari*, a short stapled high ginning cotton, has very largely been replaced by the improved strain 1027 A.L.F. (*G. herbaceum*) which has a staple length of 15/16"-1" and spins up to 24s-30s warp counts. In the Broach tract, the medium staple strain, B.D. 8 is replacing the local mixtures. This strain is highly wilt resistant and spins 30s warp against 14s-18s of the local mixtures. In the Dholleras tract, *Wagad* and *Lalio* cottons, belonging to *G. herbaceum* variety *frutescens*, are chiefly grown, but there is also a very small area in North Gujarat under the short stapled *Mathio* (*G. arboreum*) cotton.

Pests and Diseases.—The most important pests of cotton met with in Bombay consist of bollworms (spotted and pink), red cotton bug, Aphis, and Hairy Catterpillar (Kutra). Both the species of spotted bollworm, namely, *Earias fabia* and *E. insulana* are come across. Among the fungal diseases attacking cotton in this province, wilt, caused by *Fusarium Vasinfectum*, and root rot, caused by *Rhizoctonia* species, are the most important. Root rot is prevalent in the North of the Presidency and wilt in the South.

(8) Hyderabad State

The State can be divided into two distinct parts: (i) comprising Marhatwadda and Karnatak in the West and (ii) Tellingana in the

East. The soil of Marhatwadda is mostly black cotton soil, a large portion of which has been formed in site by the disintegration of the underlying Deccan trap and is not of any great depth, Karnatak district has large tracts of black cotton soil interspread with areas of red soil. Cotton in these districts is sown both on black and red soils. The soil of Tellingana is granitic, locally known as *Chalka*. It is red in colour, not very fertile and loses moisture quickly. In this region too some areas of light black soils are come across, which are invariably used for cotton cultivation.

The State has three well-defined seasons, a moderately warm wet season, June–September, a fairly temperate period, October–February, and a hot and dry season from March to May. The maximum temperatures of 114–118° F. are often recorded in Summer season. The minimum temperature rarely falls below 55° F. The annual rainfall varies from 18" in Raichur district to about 40" in Asifabad and Nalgonda districts.

Cultivation of Cotton.—Two different crops of cotton are grown in the State. The first, called Kharif crop, is sown in June or beginning of July and is harvested during October–January. This crop is mostly grown in Marhatwadda tract. The second, called Rabi crop, is sown in September and October and harvested in February–April. This is chiefly grown in Karnatak and Tellingana. Both the *Kharif* and *Rabi* crops are grown mostly under rain-fed conditions. Only here and there a few acres of American cotton are sown with irrigation from wells on garden lands. The most common method of sowing followed in the State is drilling seeds in lines, but at a few places the crop is sown broadcast also. Usually the entire crop is gathered in 3 pickings.

Varieties.—In the "Kumpta" protected area of Raichur district which is situated in the extreme South-Western portion of the State the seed of the improved variety, Jayawant (*G. herbaceum*) is being distributed. The total area under this variety was nearly 1,32,000 acres during 1940–41. In the Nanded and some other districts *Gaorani* 6, (*G. arboreum* var. *neglectum*) which is classed by trade under the name of Hyderabad Gaorani, is largely cultivated, total area covered by this variety in 1940–41 being more than 287,000 acres. In Aurangabad district an improved strain of American cotton, called Parbhani American, is being introduced with considerable success. Jarila cotton is now being introduced in the Northern districts of the State.

Pests and Diseases.—The most important pests of cotton are the pink bollworm and jassid. The former usually takes a very heavy toll while the latter is of importance only in the dry seasons,

Amongst the fungal diseases, cotton wilt (*Fusarium* sp.) is assuming importance.

(9) Madras

Cotton growing in this Presidency is confined to six well defined regions which are as follows:—

- (i) *Bellary, Anantapur and Cuddapah*.—The soil of these districts is mostly deep black and the rainfall varies from 18–22". The cotton varieties grown in this tract are designated as "Westerns".
- (ii) *Kurnool and Cuddapah*.—This tract has light black and red soils, and the rainfall in it varies from 22–28". The trade description given to cottons grown in this tract is "White and Red Northern".
- (iii) *Guntur, Kistna, Nellore and Godavari*.—The soils of this tract are of the same type as in region (ii), but the rainfall is higher (30–35"). The cottons grown here are known as "Cocanadas".
- (iv) *Madura and part of Ramnad and Tinnevely*.—These districts have black or light black soils and the rainfall in them varies from 25–35". The cottons grown here are known under the trade name of "Tinnevellys".
- (v) *Coimbatore, Ramnad and Tinnevely*.—The soil types and rainfall in this region are the same as in (iv), but different types of cotton, known as "Karunganni", are cultivated.
- (vi) *Coimbatore, Salem, Madura and Trichinopoly*.—These districts possess red loamy soils as well as heavy black soils and have a rainfall of 25–30". The cottons grown in them are designated by trade as "Cambodias" and "Salems".

Cultivation of Cotton.—With the exception of exotic Cambodia cotton which is sown on irrigated lands all other varieties are grown under rain-fed conditions. The sowing time is mostly August–November in different regions, but in the Cambodia tract sowings in March–April are also done. The preparatory tillage consists of working the blade harrow twice or thrice, or ploughing with country plough two to six times. The sowing is generally done by drilling seed in rows 2–3½' apart, but broadcasting and dibbling seeds is also sometimes resorted to. The after tillage consists of hoeing with hand hoes or working a small blade harrow twice or thrice. The picking time of the crop is January–March in the September–October sown cotton and August–September in March–April sown crop.

Varieties.—The most important strains under cultivation are H. 1 (*G. herbaceum* var. *frutecens*) in the "Westerns" tract, N. 14 (*G. arboreum* var. *neglectum* forma *indica*) in the "Northerns" tract and K-1

C-7 and A-10 (*G. arboreum* var. *neglectum* forma *indica*) in the "Karunganni" tract. In the regions where acclimatised Cambodia cotton is grown, the strain Co. 2 is most extensively grown, but two new strains (Co. 3 and Co. 4) evolved recently from crosses between Uganda and Cambodia cottons are becoming increasingly popular by virtue of their early ripening qualities, more prolific nature and superior lint characters than Co. 2. In the "Cocanadas" tract, cotton of "Bengals" type is being largely grown, but an improved strain X 20 evolved recently from this cotton has good chances of spreading in the districts concerned. In "Tinnevellies" area, the cottons grown are a mixture of *G. arboreum* and *G. herbaceum*.

Pests and Diseases.—The chief pests of cotton in Madras are bollworms, aphids, stem-weevil and jassids. Among the diseases of this crop, stenosis, wilt, angular leaf spot, root rot and black-arm are the most important. The incidence of different pests and diseases varies a good deal in different regions.

A. INSECTS WHICH DESTROY COTTON SEEDLINGS

Large Brown Cricket (*Brachytrypes portentosus* Licht.)

Name and Systematic Position.—The insect belongs to the family Gryllidæ, order Orthoptera. Its Latin names are *Brachytrypes portentosus* Licht. (*B. achatinus* Stoll.). It is commonly known as "large brown cricket".

Distribution and Status as a Cotton Pest.—The insect is a minor pest of cotton seedlings. It occurs abundantly throughout Bengal, Bihar and Nellore (Madras Presidency).

Nature of Damage.—The pest lives in a burrow in the soil which may be about 9" deep. It becomes active at night when it cuts cotton seedlings, drags them to its burrow and feeds on them.

Brief Description of the Stages.—The *eggs* are cylindrical, 4.65 mm. long, yellow when freshly laid but later on they become creamy white. They are laid in clusters in a hole in the soil. The *nymphs* are light brown in colour with a paler abdomen which has a dark tinge in the middle.

Alternative Food Plants.—In addition to cotton this insect has been found feeding on indigo, sesamum, jute, tobacco, cabbage, cauliflower, "chillies", rice and tea. In addition to these cultivated plants it feeds on casuarina also.

Life-History and Seasonal History.—Life-history of the insect is not known. The females lay eggs in September which hatch after a month. The young nymphs live in the parental burrow for some time, but older nymphs lead a solitary life, each living in its own burrow. They moult five times and reach maturity during April-June.

General Climatic Relationships.—This has not been worked out thoroughly but from general observations it appears that hot and dry climatic conditions favour its increase.

Natural Enemies and Biological Control.—*Birds*: It is preyed upon by such birds as crow, spotted owlet and black ibis.

Parasites: No parasite of this insect has so far been recorded.

Predators: It is preyed upon by a predaceous wasp *Sphex lobatus* Fab. (called the metallic green digger) which is being considered its chief enemy.

Direct Control Measures.—(1) Flooding the infested fields with water is effective in driving out the pest from its burrow when it is picked up by birds, (2) *Bait*: The insect can be controlled with a poison bait consisting of lead arsenate, sodium fluosilicate and bran; (3) Another effective bait is prepared by dipping plants like roselle or tender bamboo shoots in a poison. The treated plants are then placed near the burrow of the pest.

Reference

Ghosh, C. C. (1912-14), *Mem. Dep. Agric. India*, IV.

“Tid” (*Gryllulus viator* Kby.)

Name and Systematic Position.—The insect belongs to the family Gryllidæ, order Orthoptera. Its Latin names are *Gryllulus viator* Kby. (or *G. melanocephalus* Serv.).

Its vernacular name in the Punjab and Sind is “tid”.

Distribution and Status as a Cotton Pest.—The insect is recorded as a pest of cotton seedlings in the Punjab and Sind (at times serious) and as a pest of other crops in the United Provinces, Bihar and Bengal.

Nature of Damage.—Both adults and nymphs destroy cotton seedlings at night.

Alternative Food Plants.—In addition to cotton, this insect has been recorded as causing damage to young mango plants. In the Punjab, United Provinces and Bihar its host plants include young *rabi* (winter sown) crops while in Sind it is reported to be destructive to “jowar”.

Life-History and Seasonal History.—Not known. The adults are said to be more abundant in May-June.

General Climatic Relationships.—This has not been studied but from general observations it appears that dry weather conditions are favourable for its abundance.

Natural Enemies and Biological Control.—*Birds*: Following birds have been found preying upon it: king crow (*Dicrurus ater*), large

cuckoo shrike (*Graculus macii*), Indian myna (*Acridotheres tristis tristis*), Indian roller (*Coracias indica*), common hawk cuckoo (*Hierococy varicus*) and shikra (*Astur badius*). No insect parasites and predators of this insect have so far been recorded.

Direct Control Measures.—The effective control of the pest yet remains to be worked out but flooding the fields when the attack is in progress is reported to effect relief.

Black-headed Cricket (*Gryllulus domesticus* L.)

Name and Systematic Position.—The insect belongs to the family Gryllidæ, order Orthoptera. Its Latin name is *Gryllulus domesticus* L. Its vernacular names are “tid” and “tiddi”.

Distribution and Status as a Cotton Pest.—It is a very serious pest of cotton in Dadu and Larkana districts, and to a certain extent, in Sukkur and Jacobabad districts. of Sind.

Nature of Damage.—(This pest has come into prominence since the opening of the Lloyd Barrage in 1930-31 when the area under cotton increased from thirty thousands to one million acres.) Both adults and nymphs do damage. They feed on the newly sown cotton seeds as well as nibble off cotton seedlings at ground level when they are about 10 days old. Cotton sown during mid-April and June suffers the most and sometimes many sowings have to be done in order to secure a crop. When the plants have grown up they feed on shed leaves and fallen bolls.

In addition to cotton, this pest also destroys harvested wheat and seeds and stems of harvested “taramira” and sweet turnips during April.

Brief Description of the Stages.—The *adult* cricket is about 2.7 cm. long and brown in colour with brown patches on its head and thorax. The eggs are cylindrical, yellow when freshly laid, but become creamy white later on and greyish before hatching. The *nymphs* are brown in colour with dark patches on head and thorax.

Alternative Food Plants.—The cricket is polyphagous. When food is scarce it eats up all kinds of organic matter which comes its way. It has also been observed feeding on the flesh of carcasses.

Life-History and Seasonal History.—The insect passes the winter in the egg-stage and the nymphs from these eggs appear in March. The adults appear in June but sexes mature in September when mating and egg laying take place. Eggs are laid in the soil and each female can, on an average, lay 120 eggs in its life-time. The insect has only one brood a year.

General Climatic Relationships.—This has not been studied but it has been observed that the insect prefers dry tracts.

Natural Enemies and Biological Control.—*Birds*: The insect is preyed upon by a number of unidentified birds. No *parasites* or *predators* of this insect have so far been recorded.

Direct Control Measures.—(1) If the trench between the ridges on which cotton is sown is kept filled with water for a fortnight, the crop escapes damage from this pest. (2) *Bait*: When the attack is in progress it can be controlled with a poison bait consisting of bran 20 parts, sodium fluosilicate 1 part, *gur* or common salt 1 part and water enough to moisten. This bait is spread in the infested field before sunset. (3) When the pest is on the march it can be trapped and destroyed in trenches filled with kerosenised water. (4) The insect is attracted to strong light and this can be employed to reduce its numbers.

Reference

Janjua, N. A. (1939), *Agric. Live-Stock in India*, IX (6), p. 688.

Surface Grasshoppers

Name and Systematic Position.—The adults of surface grasshoppers belong to the family Acridiidae of the order Orthoptera. Three species of grasshoppers are included under the term “surface grasshopper” and their Latin names are as follows: (1) *Chrotogonus* sp., (2) *Aiolopus tamulus* F. and (3) *Atractomorpha crenulata* F. These are discussed below:—

Chrotogonus sp.

This insect has not yet been identified down to species (but the one causing damage to cotton in Madras has been identified as *C. saussurei* Bol.). Its vernacular names in the Punjab are “tirudda” and “toka”, in the United Provinces “tiddi”, “but”, “darki”, “jadia” and “gadho”, in the Central Provinces “raktol” and “tidi”, in Bengal “fatinga” and “godubya” and in Madras “kali-pochi”.

Distribution and Status as a Cotton Pest.—The insect is uniformly distributed throughout the plains of India. It is on the whole a minor pest excepting the Punjab where in some years it does considerable damage to germinating cotton.

Nature of Damage.—Both adults and hoppers destroy cotton seedlings.

Brief Description of the Stages.—The *adult* is a strongly built, flattened, small sized dusky coloured grasshopper which has tegmina shorter than the abdomen and rudimentary wings.

The *eggs* are elongate-oval in shape.

The *nymphs* resemble adults but differ from them in size and in the absence of wings.

Alternative Food Plants.—The insect is a general feeder and has been noticed doing damage to gram, sann-hemp, groundnut, indigo, castor, niger seed, tobacco, "jowar", "bajra", opium poppy, maize and wheat.

Life-History and Seasonal History.—Very little is known of the life-history of the pest. The females lay eggs in holes in the soil during October-November. The eggs remain in embryonic diapause until April-May when they hatch. The nymphs reach maturity in 8-10 weeks. The adults oviposit in June-August and these eggs hatch out in about 23 days, the nymphs from these eggs becoming adults in October-November.

General Climatic Relationships.—This has not been studied.

Natural Enemies and Biological Control.—*Birds*: It is preyed upon by over three dozen different species of birds of which the common myna (*Acridotheres tristis tristis*) is the most important.

Parasites: No parasites of this insect have so far been recorded.

Predators: Its eggs are destroyed by the larvæ of certain unidentified blister beetles.

Direct Control Measures.—(1) *Bait*: When the attack is in progress it can be controlled with a poison bait consisting of bran 20 parts; sodium fluosilicate 1 part, *gur* or common salt 1 part and water enough to moisten. This bait is spread in the infested field before sunset. (2) Adults and nymphs can be collected by field bags (6' × 4' × 2') or by ordinary hand nets and destroyed. (3) Baiting by Texas method proved successful in Madras but was not found effective at Pusa.

Reference

Rahman, K. A. and Lal, B. (1940), *Proc. 27th Sess. Ind. Sc. Cong.*

Aiolopus tamulus F.

Distribution and Status as a Cotton Pest.—The insect is commonly found in the plains of India particularly South India. It is a minor pest of cotton.

Nature of Damage.—Not known.

Brief Description of the Stages.—The adult is 18 mm. long, green brown or reddish in colour usually with two parallel brown stripes on the vertex running within eyes to the back of the head. Its tegmina are brown and wings greenish hyaline with dusky hind margins.

Alternative Food Plants.—The insect is a general feeder and, in addition to cotton, it has been found feeding on rice (it is a minor pest of this crop in Madras), "jowar", "bajra", maize and wheat. In addition to these cultivated plants, it has also been found feeding on such uncultivated plants as "dhaincha" and "marua".

Life-History and Seasonal History.—Not known.

Natural Enemies and Biological Control.—*Birds*: Following birds have been found preying upon this grasshopper:—(1) The Siam large racket tailed drongo (*Dissemurus paradiseus paradiseus*), (2) The jungle owlet (*Glancidium radiatum radiatum*).

Parasites and predators of this pest are not known.

Direct Control Measures.—Same as those suggested for *Chrotogonus*. In addition light traps should also be tried.

***Atractomorpha crenulata* F.**

Distribution and Status as Cotton Pest.—It is uniformly distributed in the plains of India. It is a minor pest of cotton.

Nature of Damage.—Not known.

Brief Description of the Stages.—The adult is 16–26 mm. long, green in colour with pointed tegmina and wings.

Alternative Food Plants.—In addition to cotton it feeds on tobacco (of which it is considered a pest), brinjal, arrow-root, cabbage and cauliflower.

In addition to the above mentioned cultivated plants, it also feeds on *Amaranthus* sp.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: The following birds have been reported feeding on it:—(1) King crow, (2) Indian roller, (3) Humes brown hawk owl, (4) Bhraminy kite (*Haliastur indus*), and (5) cattle egret.

Parasites: Its eggs are parasitized by a Proctotrypoid, *Seclia attractormosphæ* Mani.

Predators: Not known.

Direct Control Measures.—Same as for *Chrotogonus*.

The Desert Locust (*Schistocerca gregaria* Forsk)

Name and Systematic Position.—The desert locust belongs to the family Acridiidae of the order Orthoptera. Its Latin name is *Schistocerca gregaria* Forsk and its vernacular names are “makri”, “tidi”, “tidi dal” and “salah”.

Distribution and Status as a Cotton Pest.—Locust is one of the scourges of humanity. Within India the locust (in its solitary phase) lives permanently in Baluchistan, Sind, Rajputana, Bahawalpur State and Dera Ghazi Khan in the Punjab. In the gregarious phase it has

been known to go as far east as Assam and as far south as Arcot (Madras Presidency).

Nature of Damage.—Hoppers are more destructive than adults: They destroy practically all types of vegetation: in the last locust invasion (1926-1931) even the bark of grown-up cotton plants was eaten.

Brief Description of the Stages.—For this kindly see Uvarov's "Locust and Grasshoppers", pages 32-64.

Alternative Food Plants.—The insect is polyphagous. During 1926-31 invasion, however, it did not attack "drek" and "ak" (an uncultivated plant) and did a little damage to "guara".

Life-History and Seasonal History.—In the Punjab the insect breeds twice a year, *i.e.*, February-April and then again July-September. Mating lasts for 24 hours or so. Soon after mating female drills a hole 2"-6" deep in the ground at the bottom of which she deposits 80-100 eggs: there may be upto 87 such holes per square foot. Eggs are laid in dry beds of rivers and streams, sand dunes, ploughed up fields; the females prefer to lay eggs in light soil. Depending upon the texture of the soil a female takes 1-4 hours to make a hole and lay eggs. Each female is capable of laying more than 850 eggs, which she lays in instalments within 8-74 days of becoming bright yellow. These eggs hatch in 15-28 days in February-May and 12-15 days in July-October. The newly hatched larva reaches the surface of the soil encased in sac-like covering which is shed shortly after emergence from the hole. The hopper stage lasts for 32-52 days in March-May and 25-37 days in July-September.

The adults are long-lived insects: those emerging in April-May live till July-October and those emerging in August-October live till February-May.

General Climatic Relationships.—It is a tropical insect which has its threshold of development at about 18° C.

Natural Enemies and Biological Control.—*Birds*: About 26 different species of birds have been found in the Punjab preying upon the adults and hoppers of locust, the most important of which are Bengal jungle babler (*Turdoides terricolor terricolor*), king crow and rosy pastor (*Pastor roseus* Linn.), the last named being an inveterate locust enemy.

For *parasites*, *predators* and diseases of locust kindly see Uvarov's "Locust and Grasshoppers", pages 102-133, 133-136 and 136-143, respectively.

Direct Control Measures.—*Egg destruction*: The eggs are dug up from the soil by ploughs, spades, etc.

Destruction of adults: The mating and egg-laying adults are destroyed by beating them with (a) brooms, (b) thorny branches of

trees, (c) running a roller over them, (d) getting them trampled by flocks of sheep, goat and cattle. The adults can also be destroyed by poisoning and burning (see below).

Destruction: Hoppers are destroyed by (a) burning them with flame throwers (see "Agriculture and Live-stock in India", Vol. I, Part IV, p. 382, July 1931).

(b) *Trenching:* A trench 1-2½' wide and 1½-2' deep is dug and the hoppers driven to it. In the trench deep pits at regular intervals are dug up to increase its capacity. When full with hoppers the trench is earthed up.

(c) *Erection of barriers:* Where trenching is not possible 10-12" high above ground iron sheet barriers are erected. These barriers are erected in a straight line with pits extending along their length or in the form of V with a big pit at the apex of V.

(d) *Poisoned baits:* This bait consists of 50 lbs. bran, 2½ lbs. sodium fluosilicate, molasses 6 lbs., water 2 gallons. The bait is broadcast early in the morning at the rate of 20-30 lbs. per acre depending upon the intensity of attack.

References

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Dark Brown Weevil (*Atactogaster finitimus* Fst.)

Name and Systematic Position.—The adult belongs to the family Curculionidæ of the order Coleoptera. Its Latin name is *Atactogaster finitimus* Fst. and its common name is "dark brown weevil".

Distribution and Status as a Cotton Pest.—The insect is a local pest of sporadic importance in some districts of Madras Presidency and in the Hyderabad State.

Nature of Damage.—The insect cuts seedlings and devours them. It also destroys leaves of mature plants.

Brief Description of the Stages.—The adult is a stoutly built, dark brown to black weevil with a prominent beak.

Alternative Food Plants.—It feeds on most of the low growing crops.

Life-History and Seasonal History.—This has not been studied. The adults appear towards the end of June in Hyderabad where cotton is a “rabi” (winter-sown) crop. When the sun is hot the adults hide in cracks in the soil.

General Climatic Relationships.—This is not definitely known but precipitation appears to favour its abundance.

Natural Enemies and Biological Control.—*Birds* enemies, *parasites* and *predators* of this insect are not known.

Direct Control Measures.—(1) *Hand-picking*: The adults are best dealt with by hand-picking, (2) the adults can be attracted to fresh leaves which are placed at the corners of the infested fields and destroyed.

Grey Weevil (*Mylocerus Blandus* Fst.)

Name and Systematic Position.—The insect belongs to the family Curulionidæ of the order Coleoptera. Its Latin name is *Mylocerus blandus* Fst. It is commonly known as “grey weevil”. In the Punjab it is popularly known as “chor kira”.

Distribution and Status as a Cotton Pest.—The insect is recorded as a minor pest of cotton, etc., in the Punjab, Madras and the Central Provinces.

Nature of Damage.—The adults gnaw off seedlings at night or early in the morning just below or above ground level.

Brief Description of the Stages.—The *adult* measures $2\frac{1}{2}$ –3 mm. in length and is black in colour with a number of white and dark spots on its elytra.

The *eggs* are ovoid, light yellow in colour and are laid in the soil singly.

The *grubs* are legless, 7 mm. long and dirty white in colour.

The *pupæ* are creamy white in colour and are found in the soil in a small earthen cell.

Alternative Food Plants.—The insect is polyphagous and has been recorded as causing damage to the following plants in addition to cotton, “bhindi”, maize, “jowar”, wheat, “moti”, “urid”, rice, sugarcane, carrot, sannhemp, strawberry, guava, brinjal, pumpkin, poppy and “arhar”. In addition to these cultivated plants it feeds on jamarix sunflower and sissu also.

Life-History and Seasonal History.—This is not known. The adults become active in April when they attack cotton seedlings and maize. After the middle of May they are found feeding on maize and jowar while in June they are mostly confined to “jowar”.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: Following birds have been recorded as feeding on this pest:—(1) Jungle babbler (*Crateropus caporus*), (2) common lora (*Aegithina Tiptira*), (3) Bengal red vented bulbul (*Molpastes bengalensis*), (4) Indian tailor bird (*Orthotomus nitorius*), (5) brown willow warbler (*Phylloscopus tristis*), (6) oriole (*Criolus melanocephalus*), (7) black partridge (*Francolinus vulgaris*).

Parasites: The insect is parasitised by the following:—(1) *Loxoccephalus* sp. (Family Euphoridæ) and (2) Nematode worms.

Predators of this pest are not known.

Direct Control Measures.—No satisfactory control of the pest is known. Light traps may be tried. Crude oil emulsion mixed in irrigation water is said to keep away the pest.

Cutworm or Surface Caterpillar (*Agrotis flammatra* Schiff.)

Name and Systematic Position.—The moth belongs to the family Noctuidæ of the order Lepidoptera. Its Latin name is *Agrotis flammatra* Schiff. It is commonly known as the “gram cutworm”.

Distribution and Status as a Cotton Pest.—It is an exotic species from temperate climates which is now found throughout Northern India. It is a minor pest of cotton but a major pest of gram, potatoes, wheat seedlings and young cucurbits.

Nature of Damage.—Only caterpillars do damage. They spend the day in hiding about the base of the plants next to cut plants in the top 3–4” of the soil. They become active at night when they cut down or “fell” young plants mercilessly just above, at or slightly below the surface of the soil.

Brief Description of the Stages.—The *adult* is a heavy bodied grey brown insect which measures $2\frac{1}{2}$ inches in the wing expanse. Its front wings have the following characteristic markings: two-third of the coastal area pale, a grey brown kidney-shaped spot, and a semi-circular spot below the pale area, two black wavy lines near the base.

The *eggs* are yellowish white and are generally laid on the underside of the leaves.

The *caterpillars* are dark grey in colour. Their skin is smooth and greasy in appearance.

The *pupæ* are reddish brown in colour and are found in cells in the soil.

Alternative Food Plants.—It is polyphagous and the following are some of its recorded food plants in addition to cotton: gram, peas, poppy, “bhindi”, tobacco, potato, wheat and young cucurbits.

In addition to the above cultivated plants it also feeds on “piazi”.

Life-History and Seasonal History.—The adults are active at night. Eggs hatch in 4–5 days in April–May and 14 days in December. The caterpillars are full-grown in 2–4 months. The pupal stage occupies 18–20 days in April–May.

General Climatic Relationships.—It is a temperate zone species which during summer is found in the hills from where it descends to the plains during winter by migrating in large swarms at night.

Natural Enemies and Biological Control.—*Birds:* It is preyed upon by 20 different species of birds the most important of which are:—

- (1) The Indian tree-pie *Dendrocitta rufa rufa* Latham.
- (2) The Bengal jungle babbler *Turdiodes terricolor terricolor* Hodgs.
- (3) The brown backed Indian robin *Saxicoloides fulicata cambaiensis* Lath.
- (4) The Indian grey shrike *Lanius excubitor lahitara* Sykes.
- (5) The bay-backed shrike *Lanius vittatus* Valenc.
- (6) The black drongo or king crow *Dicrurus macrocercus macrocercus* Vieill.
- (7) The common myna *Acridotheres tristis tristis* L.

These birds generally keep the pest under check.

Parasites: The larvæ are parasitised by the following—(1) *Gonia prinveseans* Viell. (*Tachinidæ*), (2) *Fileanta rufocauda* (*Braconidæ*) (3) *Amblycteles* sp. (*Braconidæ*).

Predators: These are not known.

Direct Control Measures.—The pest is usually kept in check by its numerous bird and insect enemies. It can be effectively controlled by poisoned bran mash (see page 27). The bait should be sown broadcast or placed in small heaps in the infested field in the evening. In small plots the pest can be destroyed by hand-picking, hand-hoeing or by first attracting it to cut pieces of turnips or potatoes covered by “piazi” and then killing it.

Important Note.—The other “cutworms” found in India are (1), *Euxoa segetum* Schiff. and (2) *Euxoa spinifera* Hb. The first named occurs throughout India and is considered a major pest of garden crops while the second one which also occurs throughout is a pest of grasses: it has been recorded only once as causing damage to cotton in Gujerat district. These insects resemble *Agrotis flammatra* in their habits and mode of life.

References

- Lefroy, H. M. (1907), *Agric. Jl. India*, II (1), p. 42.
 Lefroy, H. M. and Ghosh, C. C. (1907), *Mem. Dep. Agric. India*, Ent. Ser I, (3), p. 253,

Lucerne Caterpillar (*Laphygma Exigua* HB.)

Name and Systematic Position.—The moth belongs to the family Noctuidæ of the order Lepidoptera. Its Latin name is *Laphygma exigua* Hb. Its common name is "lucerne caterpillar". In Egypt it is commonly known as "lesser leaf worm".

Distribution and Status as a Cotton Pest.—The insect is found in America, Rhodesia, Spain, France, Sudan, Russia, Japan, China, Australia, Bulgaria, Egypt, Sicily, Turkistan and India; in the last named country it is widely distributed.

It is recorded as a minor pest of cotton in the Punjab (in July 1934, however, it did serious damage in Montgomery to cotton crop near a lucerne field) and Central Provinces. It is recorded as a serious pest of lucerne and indigo throughout its range while in South India it is a major pest of tobacco in addition.

Nature of Damage.—The caterpillars destroy cotton seedlings in the Punjab and cotton leaves in the Central Provinces.

Brief Description of the Stages.—The moth measures $\frac{3}{4}$ inch across the wings. It is pale yellowish-brown in colour. Its hind wings are white and have dark veins and dark outer margins, and its front wings are dark: they have marginal series of dark spots mottled with small ochraceous spots and a kidney-shaped spot which has a dark centre.

The eggs are dark brown. They are laid in clusters (of 10–80 on leaves) which are covered with buff coloured hairs from the body of the female.

The caterpillar when full-grown measures a little over an inch in length. It is green in colour and has a white stripe down each side of its body which has a distinct pinkish tinge.

The pupa is dark brown in colour with 2 spines at tip of its body.

Alternative Food Plants.—Though polyphagous insect it really is a serious pest of lucerne and indigo. Besides these plants and cotton this insect has also been found feeding on the following:—cowpeas "agathi", "til", linseed, jute, maize, "senji", "shaftal", "berseem", sugarbeet, silverbeet, brinjal, chillies, onion, "bhindi", radish, pea, gram, lentil, "mung", castor, "kakama", coriander, young sugarcane, cauliflower, "ambadi", "ragi" and tobacco.

In addition to the above cultivated plants it feeds on sand dune, *Amaranthus* sp., marigold and safflower.

Life-History and Seasonal History.—The insect flies and pairs at night. Each female can lay up to 200 eggs. The eggs hatch within two days. The young caterpillars feed gregariously for 2–3 days but afterwards they separate, each spinning a web over the top leaves and eating the leaf tissue under protection of this web. They feed in

the mornings and evenings and spend the remaining part of the day hiding in folds of leaves and under clods. They are full-grown in 8-13 days during May-October and 15-24 days in November-April. They pupate in the soil at a depth of about an inch in a delicate cocoon prepared by fastening soil particles. The pupal stage lasts for 3-4 days in May-October and 20-40 days in November-April.

Speaking generally the pest breeds throughout the year.

General Climatic Relationships.—Pupæ kept in hot and dry air often fail to produce adults.

Natural Enemies and Biological Control.—*Birds*: It is preyed upon the following birds:—(1) Brown backed Indian robbin (*Saxicoloides fulicatus cambaiensis* Leth.), (2) king crow, (3) myna (*Acridotheres tristis tristis*).

Parasites: Following parasites have been bred from its caterpillars in the Province noted against each:—

(1) *Punjab*.—Fam. Braconidæ: *Chelonus rufus*, *Ascogaster* sp.,
Microplitis rufiventris.

(2) *Central Provinces*.—Fam. Ichneumonidæ: *Diocles argento-pilosa* Cam.

(3) *Madras*.—Fam. Tachinidæ: *Sturmia inconspicuoides*.

Predators: Its caterpillars are preyed upon by the following predators:—Diggar wasp, *Ammophila*, unidentified carabid beetles, *Canthecona furcellata* (Sphegidæ) and *Rhinocoris fuseipes* F. Reduviidæ).

Direct Control Measures.—This pest is most active in lucerne fields from April-September. During this period the infested crop should be cut close to the ground and watered heavily. This will kill the larvæ as well as pupæ. Young crops of lucerne as well as crops of maize, gram (in gram it is active from October-March) and cotton should be protected by dusting them with sodium fluosilicate mixed with ashes or road dust in the ratio of 1 : 8 or spraying with lead arsenate, at the rate of 4 lbs. in 100 gallons of water per acre. Regular destruction of egg-clusters from an infested field also affords relief.

Bait: Bait mentioned under locust (page 27) is also useful against this pest.

Trenching: This insect is in the habit of marching in dense bands like an army. Trenching the infested fields helps to keep back this insect from spreading to uninfested fields.

Tobacco growers in Madras, control it by (1) light traps, (2) growing "marua" as a trap crop, (3) spraying with lead arsenate and (4) hand-picking.

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Red Hairy Caterpillar (*Amsacta moorei* sara Swinh.)

Name and Systematic Position.—The moth belongs to the family *Arctiidae* of the order *Lepidoptera*. Its Latin name is *Amsacta moorei* sara Swinh. Its common name is “red hairy caterpillar” and it is locally known as “katra” in Gujerat and “kutra” in the Punjab.

Distribution and Status as a Cotton Pest.—The insect has so far been found feeding on a number of plants—cultivated and wild—in the Punjab, Bombay, Madras, and Delhi. As a pest of cotton it has been responsible for a lot of damage to early sown varieties of cotton in North Gujerat (Bombay) and to cotton sown in red soils in Madras.

Nature of Damage.—Young caterpillars feed on the leaves and reduce them to papery tissue. Afterwards they devour the entire germinating crops and also feed on weeds.

Brief Description of the Stages.—The *moth* is a strongly built white coloured insect, which has shape of antennæ, anterior margins of prothorax, front wings and the whole of the abdomen scarlet, the last named segment being ornamented with black bands and dots.

The *eggs* are round and light yellow in colour. They are laid in clusters of 97–880 eggs usually on the underside of leaves of its host plants.

The young *larvæ* are brownish black in colour. The full-grown caterpillars are 2–2½ inches in length. They are orange or black in colour with their body densely clothed in long urticating hairs which arise from distinct tubercles.

The *pupæ* are chocolate brown in colour.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to the following cultivated crops in addition to cotton:—soybeans, “moth”, “mung”, “urid”, “val”, sannhemp, “til”, maize, castor, groundnut, “jowar”, “bajra”, “marus” and “guara”.

In addition to the above, it has been found feeding on the following weeds and hedge plants also:—“thoria”, “arni”, “chida grass”, “kathimbdi” and “lani”.

Life-History and Seasonal History.—The pest has a single brood in a year. The adults appear on the wing any time between mid-June and mid-July depending upon [a fairly heavy shower of monsoon rains. The phenomenon of “assembling” is prevalent in these months: the female emits an odour which attracts the males of the neighbourhood in flocks around her.

A female can lay more than 1,500 eggs. The eggs hatch in 2–3 days. The caterpillars are active and when young they feed gregariously on the leaves of a weed called “lani”. When maize and jowar, etc.,

crops germinate, these caterpillars migrate to them in large hordes. After devastating a field, they move out of it into an adjoining one like an army. These caterpillars are common in June–August. A caterpillar is full grown in 15–23 days. These full-grown caterpillars enter soil to a depth of 9" where they prepare a chamber in which pupation takes place. The pupal stage lasts for about 11 months.

General Climatic Relationships.—In Northern Gujerat this pest is prevalent in areas with light soil because such soils do not retain moisture for a long time during monsoons. In Madras they are met with in red soils.

Natural Enemies and Biological Control.—*Birds* enemies, *parasites* and *predators* of this insect are not known.

Direct Control Measures.—The moths fly at night. They are strongly attracted to light. The most effective and cheap method to deal with this pest, therefore, is to put up light traps regularly during the period when the moths are flying about. There should be one light trap for every 4 acres. This light trap consists of a hurricane lamp placed on a brick lying in the middle of an earthen or iron vat ("kunal") containing water with a film of kerosene oil on its surface, the whole of the apparatus being placed 3–4 feet high on a mound of earth. When the caterpillars are advancing from one field to another they should be stopped by digging a trench in front of the marching army. The side of the trench opposite to the marching army should be smooth and perpendicular. The caterpillars trapped in the trench should be buried. Young caterpillars should be jerked off the plant into a receptacle containing kerosenised water. Another effective method to deal with the caterpillars is to dust the plants with sodium fluosilicate, 1 part of it mixed with 8 parts of ashes.

Hand-picking: The caterpillars can also be hand-picked. In 1911, Jhavery got collected about 282 pounds of these caterpillars at a cost of less than a shilling per acre.

Reference

Patel, C. U. (1908), *Agric. Jl. India*, III (2), p. 152.

B. INSECTS WHICH DESTROY COTTON LEAVES

1. BITING

Cotton Leaf Roller (*Sylepta Derogata* F.)

Name and Systematic Position.—The moth belongs to the family Pyralidæ of the order Lepidoptera. Its Latin name is *Sylepta derogata* F. It is commonly known as the "cotton leaf roller".

Distribution and Status as a Cotton Pest.—The pest is widely distributed in Asia and Africa. It occurs throughout India as a

minor pest of cotton: it shows special preference for American cottons particularly those which are tall and bushy: in the Punjab the following American varieties are specially favoured by it: K.T. 25 and 289F.

Nature of Damage.—Damage is done by caterpillars. When young the caterpillar feeds on the lower surface of a leaf, but when older it rolls up leaves (trumpet-like) from edges towards the mid-rib on which it feeds. In some cases a leaf may have three rolls. Major portion of an attacked leaf is eaten up entirely and in the remaining portion it eats big holes. The attacked leaf drops off the plant. In severe cases of infestation there may be 4,000 caterpillars in an area of half a "marla" ($16\frac{1}{2} \times 8\frac{1}{4}$ ft.).

Brief Description of the Stages.—The moth is about $\frac{1}{2}$ inch long with a wing expanse of about an inch. It is yellowish white in colour and its wings are spotted with black-brown dots and zig-zag lines which impart to it a gayish appearance.

The eggs are round and pale yellowish-green. They are laid singly usually on the underside of leaves along thicker veins.

The caterpillar when full fed is $1\frac{1}{8}$ inch long and greenish in colour with a dark brown head, but before pupation it becomes pinkish.

The pupa is reddish-brown in colour. It is found either in the roller leaf or on the ground among fallen leaves which are stitched together by silken threads.

Alternative Food Plants.—In addition to cotton it has been recorded as causing damage to "bhindi".

In addition to cotton and "bhindi" it also feeds on *Hibiscus parviformis*, "Sonchal", "dheras", hollyhock, "kangi", "kuchri" "ban ochra", *Corchorus* sp., *Sida* sp., prickly chaff flower, "ban bhendi" and "jatadhari".

Life-History and Seasonal History.—Its attack always starts in those fields of American cottons which are adjacent to the forest plantation in the plains, e.g., Khanewal, Changa Manga, and the forest area in Gujarat.

The pest winters over as a full-grown pinkish larva among fallen leaves and flower buds. These larvae pupate in the second week of February from which moths appear in March. They remain active till November. The females lay eggs along thicker veins on the underside of leaves and these eggs hatch out in 4-6 days into yellowish caterpillars. A larva is full-grown in 12-24 days. The pupal stage occupies 5-8 days during May-September.

General Climatic Relationships.—It is considered that damp and cloudy weather favours the increase of this insect.

Natural Enemies and Biological Control.—*Birds*: Of the 36 different species of birds which prey on this insect the following are the most important:—Himalayan starling, rosy pastor, myon, Indian house crow, babblers, king crow and the Indian roller.

Parasites: In the Bombay Presidency the following parasites have been bred from its caterpillars:—(1) *Neopimplodes sylepta* Vier (Ichneumonidæ), (2) *Microtoridea lissonata* Vier (Ichneumonidæ), (3) *Elasmus indicus* Rob. (Elasmidæ), (4) *Microbracon recinicola* (Braconidæ), (5) *Phanerotoma* sp. (Braconidæ). In addition to these following have also been bred from it:—*Heinocospilus atricornis* Morley (Ichneumonidæ), *Apanteles* sp. (Braconidæ) and *Elasmus brevicornis* Gub. (Elasmidæ).

Predators of this pest are not known.

Direct Control Measures.—The birds which prey upon this pest should be protected and encouraged in areas liable to outbreaks of the pest. The infested fields should be watered and ploughed with a furrow turning plough to bury the hibernating caterpillars. Alternative food-plants should be eradicated during April–August. Rolled leaves with caterpillars in them should be hand-picked in the beginning of the attack: 4 men can clear off the pest from 1–10 acres in three hours, depending upon the size and spread of the plants and the intensity of attack. Dusting the plants with sodium fluosilicate, one part in 8 parts of ashes at the rate of 8 lbs. per acre is also useful. Dusting should be carried out in the morning.

References

- Husain, M. A. and Bhalla, H. R. (1937). *Ind. Jl. Agric. Sci.*, VII (5), p. 785.
 Lefroy, H. M. (1910), *Mem. Dep. Agric. India*, Ent. Ser. II (6), p. 95.

Green Semilooper (*Anomis flava* F.)

Name and Systematic Position.—The moth belongs to the family Noctuidæ of the order Lepidoptera. Its Latin names are *Anomis flava* F. (*Cosmophila indica* Gn.). It is commonly known as “green semi-looper”.

Distribution and Status as a Cotton Pest.—The insect occurs throughout India as a sporadic pest of cotton particularly of exotic varieties.

Nature of Damage.—The caterpillars eat up the entire leaf tissue and leave only the veins behind. They may also injure tender shoots, buds and bolls.

Brief Description of the Stages.—The male *moth* has its head and thorax orange yellow, irrorated with brown; its abdomen is dorsally brown. Its wings are fuscous with the cilia white at tips. The

females are bright orange yellow and with forewings slightly speckled with red.

The *caterpillar* when full grown measures 25–30 mm. in length. It is green in colour with five white lines on the back and the sides.

Alternative Food Plants.—In addition to cotton it has been found feeding on “bhindi”, Deccan hemp and “urid”.

In addition to these cultivated plants it feeds on the following plants also:—shoe flower, “briar”, hollyhock, silk cotton tree, “ban bhindi”.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—The pest appears in an epidemic form in years of heavy rainfall. It is not common in the dry areas of the Punjab and Sind.

Natural Enemies and Biological Control.—*Birds*: Crows prey upon it.

Parasites: Following parasites have been bred from its caterpillars:—Bred at Pusa: *Carcelia kockiana* Towns, bred at Madras: *Sturmia macrophallus* Bar. (Tachinidæ), *Actia monticola* Mall. (Tachinidæ) and *Exorista apicalia* Bar. (Tachinidæ).

Predators: Unidentified wasp.

Direct Control Measures.—*Hand-picking*: Caterpillars should be shaken over a pail containing water with a film of kerosene oil on the surface. *Spraying*: In experimental plots plants should be sprayed with lead arsenate (2 lbs. in 100 gallons of water).

Semilooper (*Acontia graellsii* Fsth.)

Distribution and Status as a Cotton Pest.—This insect has so far been recorded as a minor pest of particularly exotic varieties from the Punjab, Bombay, Madras, Hyderabad, Central Provinces and Bengal.

Nature of Damage.—The damage done by this insect is similar to that described in the case of “green semilooper”. It feeds only in the mornings and evenings.

Brief Description of the Stages.—The *moth* is bright cream yellow in colour.

The *caterpillar* when full grown measures 45 mm. in length and is green in colour. Its back is ornamented with black horse-shoe shaped marks and a few scattered black warts from which arise single short hairs.

The *pupa* are found in cocoons made from soil particles and dried leaves.

Alternative Food Plants.—In addition to cotton this insect also feeds on “bhindi” and Deccan hemp.

In addition to these cultivated plants it also has been recorded as feeding on "kangi" and hollyhock.

Life-History and Seasonal History.—This has not been studied so far.

General Climatic Relationships.—Continued wet weather is considered to be favourable for its increase.

Natural Enemies and Biological Control.—*Bird* enemies, *parasites* and *predators* of this pest are not known.

Direct Control Measures.—Same as those suggested for *A. flava* above.

Cotton Semi-looper (*Tarache notabilis* Wlk.)

Name and Systematic Position.—The moth belongs to the family Noctuidæ of the order Lepidoptera. Its Latin name is *Tarache notabilis* Wlk. and its common name is "semi-looper".

Distribution and Status as a Cotton Pest.—The insect occurs throughout the plains of India as a minor sporadic pest of cotton.

Nature of Damage.—The caterpillars destroy leaves and in severe cases of infestation a plant may be completely denuded of them.

Brief Description of the Stages.—The *adult* is a stoutly built, handsome insect of white colour and measures about 1-1½ inch in wing expanse. The front wings are marked with four black spots on the coastal margin and with a lead coloured band on the apical margin which is followed by a black line made up of crescent-shaped marks.

The *eggs* are round and greenish in colour. They are laid singly on the underside of cotton leaves.

The *caterpillars* are dark green or brown in colour and are about 1-1½" long when full grown. They have 6 pairs of black and bright yellow spots on their backs.

The *pupæ* are chocolate brown and are found in earthen cells in the soil about 1½" deep.

Alternative Food Plants.—In addition to cotton it has been found feeding on brinjal also; among uncultivated plants it has so far been found on "sonchal".

Life-History and Seasonal History.—In the Punjab the insect spends the winter (November–March) as hibernating pupæ at the bases of cotton plants. The moths which are nocturnal in habit, appear on the wings in March–April. The eggs hatch in 2–4 days. The caterpillars are full grown in 9–16 days. The pupal stage occupies 5–14 days. All stages of the pest are present during April–October.

In Bombay, Hyderabad and Madras the insect starts activity after the break of wet weather in June–July.

General Climatic Relationships.—High humidity and mild temperature are very favourable for the rapid increase of the pest, while dry weather is said to retard its multiplication.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known.

Parasites: Two parasites namely *Tricholyga sorbillans* and *Actia-monticola* Mall. (Tachinidæ) have been bred from the caterpillars of this pest.

Predators of this pest are not known.

Direct Control Measures.—When “kapas” is harvested, the cotton sticks should be pulled out and the land ploughed up to kill hibernating caterpillars. Rotations in which “senji” (cotton, “senji”, wheat) follows cotton are also helpful in creating conditions which are detrimental to the pupæ. The caterpillars should be hand-picked and destroyed. The attacked plants should be dusted with Paris green and ashes or road dust in the proportion of 1 : 32. Dusting should be done with a dusting machine.

Important Note.—Following other species of *Tarache* are also reported to be minor pests of cotton: *T. nitidula* occurs throughout India. *T. opalinoides* is met with in central and southern India and *T. basifera* Wlk. has been recorded from the Punjab. Nothing very much is known about these pests.

Tobacco Caterpillar (*Prodenia litura* F.)

Name and Systematic Position.—The adult belongs to the family Noctuidæ of the order Lepidoptera. Its Latin name is *Prodenia litura* F. (*P. littoralis* B. or *P. retine* Frns.). Its is commonly known as “tobacco caterpillar”.

Distribution and Status as a Cotton Pest.—It occurs commonly throughout India as a minor pest of young cotton plants.

Nature of Damage.—It destroys leaves and young soft stem of cotton.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to the following cultivated crops in addition to cotton:—Castor, banana, “jowar”, tobacco, “maize”, rice, linseed, Indian hemp, cabbage, *B. deracea canla rape*, cauliflower, potato, arhar, “til”, groundnuts, sugarcane, lucerne, apple, “urid”, radish, brinjal, tomato, onion, celery, indigo, wheat, “patson”, “ragi”, poppy and cowpeas.

In addition to the above it feeds on the following uncultivated plants also: Lantana, “dhaincha”, sunflower, *Jasminum*, “gular” *Ficus infectoria*, “jent”, *Polygonum glabrum* and mulberry.

Life-History and Seasonal History.—The adults copulate on the first night after emergence and oviposition begins on the second night. Eggs are laid in bunches of 104–500 more commonly on the upper side of a leaf. They hatch in 3–4 days in summer and 8 days in winter. The caterpillars are full-fed in 16–18 days. Full-grown caterpillars burrow in moist soft soil to a depth of 2" where they construct an earthen cell in which they pupate. The pupal stage lasts for 9–14 days.

All stages of the pest are present during March–November: it passes the winter as hibernating pupæ.

In Madras the pest is active throughout the year.

General Climatic Relationships.—Not worked out in India.

Natural Enemies and Biological Control.—*Birds*: Crows and mynas (*Acridotheres tristis tristis*) have been observed to feed on its caterpillars.

Parasites: Eggs are parasitized by an unidentified Hymenopterous parasite while its caterpillars are parasitised by *Apanteles prodenia* vies (Braconidæ) and *Diocetes argentiopilosa* Cam. (Ichneumonidæ) as well as by an unidentified Tachinid.

Predators of this pest are not known.

Direct Control Measures.—*Hand-picking*: Clusters of eggs and batches of newly hatched caterpillars should be hand-picked and destroyed. *Trenching*: A trench should be dug round the affected area to prevent the caterpillars from migrating to the neighbouring fields. *Spraying*: The attacked crop should be sprayed with lead arsenate to control the pest.

Reference

Lefroy, H. M. (1908–12), *Mem. Dep. Agric. India*, Ent. Ser. II (5), p. 79.

Bihar Hairy Caterpillar (*Diacrisia obliqua* Wlk.)

Name and Systematic Position.—The insect belongs to the family Arctiidæ of the order Lepidoptera. Its Latin name is *Diacrisia obliqua* Wlk. and common name "Behar hairy caterpillar".

Distribution and Status as a Cotton Pest.—The insect is distributed over greater part of India and is considered as a minor pest of cotton: it has so far not been recorded from North-West India.

Nature of Damage.—The caterpillar feeds on the lower epidermis and parenchyma of leaves.

Brief Description of the Stages.—The male *moth* measures 42–58 mm. in the wing expanse and is pale buff in colour. Its crimson abdomen is ornamented with lateral and sub-lateral series of black spots. The *female moth* measures 50–66 mm.

The *caterpillar* is black and hairy and when full grown it measures 40 mm.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to the following crops in addition to cotton:—Soybean, “mung”, “lobia”, sweet pea, cluster bean, peas, sword bean, “til”, castor, linseed, groundnut, “patson”, banana, tobacco, Indian hemp, *Cucumis longa*, wheat, cabbage, cauliflower, lucerne, lettuce, Deccan hemp, sweet potato and artichoke.

In addition to the above it feeds on the following non-cultivated plants:—mulberry, sunflower, musk mallow, “kanghi”, marigold and chrysanthemum.

Life-History and Seasonal History.—The female lays eggs in clusters on the underside of leaves. Each cluster is covered over with buff coloured hairs. The eggs hatch in 5 days in August–September and 11 days in November–December. The larval stage occupies 21–30 days. Pupation takes on the surface of the soil or amongst leaves which are stitched together with silken threads. The pupal stage lasts for 9–10 days.

The insect passes through 8 broods in a year: a generation being completed in 5–6 weeks during June–September and 2½ months in winter.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Bird enemies of this insect are not known.

Parasites: The caterpillars are parasitized by both Dipterous (Tachinidæ) and Hymenopterous parasites. Of the former, two have been identified as *Sturmia inconspicua* Baran and *Carceliabuiten orgensis* Baran.

Predators of this pest are not known.

Direct Control Measures.—(1) *Egg collecting:* Egg clusters should be promptly hand collected and destroyed. (2) *Light trap:* The adults are attracted to light. Light trap should, therefore, be put up to destroy them.

References

- Lefroy, H. M. (1906), *Agric. Jl. India*, 1 (3), p. 187.
Lefroy, H. M. (1904), *Agric. Res. Inst. Pusa Bull.*, No. 1.

Hairy Caterpillars (*Euproctis fraterna* Moore and *E. lunata* Wlk.)

Name and Systematic Position.—The moths belong to the family Lymantriidæ, order Lepidoptera. The Latin names of the two species are *Euproctis fraterna* M. and *E. lunata* Wlk. They are commonly known as “hairy caterpillars”.

Distribution and Status as a Cotton Pest.—Both *E. fraterna* and *E. lunata* are distributed throughout India. *E. fraterna* is commoner and sometimes occurs as a sporadic major pest of some crops other

than cotton of which it is only an occasional pest, while *E. lunata* is a very minor pest of crops. *E. fraterna* has been recorded as a pest of cotton in the Punjab, Bombay, and Madras and *E. lunata* at Dharwar (in Bombay).

Nature of Damage.—The caterpillars destroy leaves.

Brief Description of the Stages.—*E. fraterna* moth has short and square fore-wings, its head, thorax and fore-wing being of a bright orange colour.

Male *E. lunata* moth is pale bright ochraceous and its fore-wings have a large black lunule on discocellulars. The female has a brown ochraceous anal tuft.

The eggs of *E. fraterna* are round in shape and creamy yellow in colour. They are laid on the lower surface of leaves in a batch which is covered with hairs from the anal tuft of the female.

The newly hatched caterpillar of *E. fraterna* is $2\frac{1}{2}$ mm. long, slender, hairy and yellowish. Full-grown caterpillar is stoutish and is dark reddish brown in colour with bright orange head and prothoracic shield. Its body is thickly covered with tufts of whitish hairs those on either side of the head being larger, darker and directed forward: its anal segment is furnished with a single similar tuft which is directed backwards.

The pupa of *E. fraterna* is red brown in colour and is found in a slight cocoon interwoven with larval hairs.

Alternative Food Plants.—*E. fraterna* has been recorded as causing damage to the following cultivated plants in addition to cotton:—"ber" banana, "arhar", pear, castor and cowpea.

In addition to the above *E. fraterna* has been found feeding on the following uncultivated plants also:—*Tylophoea asthmatica*, sunflower and croton.

E. lunata has been recorded as causing damage to the following cultivated plants in addition to cotton:—castor, "ber", mango and mulberry.

Life-History and Seasonal History.—This has not been worked out in detail. In Madras the life-cycle of the pest is completed in 41 days as follows: Egg stage, 7; larval stage, 30; pupal stage, 4.

General Climatic Relationships.—This has not been studied so far.

Natural Enemies and Biological Control.—Bird enemies and predators are not known. Eggs of *E. lunata* are parasitised by *Aholens euproctiscidis* Mani.

Direct Control Measures.—*Egg collecting:* Egg clusters are hand-picked and destroyed.

Destruction of caterpillars: Young caterpillars feed gregariously on leaves. Such leaves are plucked and dropped in water with a film of kerosene oil on the surface.

Leaf-miner (*Lithocolletis triarcha* Meyr.)

Name and Systematic Position.—The moth belongs to the family Gracilariadæ, order Lepidoptera. Its Latin name is *Lithocolletis triarcha* Meyr. and its common name "leaf-miner".

Distribution and Status as a Cotton Pest.—The insect is most probably widely distributed but as a cotton pest particularly of exotic varieties and tree cotton which it prefers, it is of very minor importance indeed. It has so far been found feeding on cotton leaves at Pusa (Bihar) only.

Nature of Damage.—The lower surface of the attacked leaf turns yellowish white and has a number of brownish spots on it.

Brief Description of the Stages.—The *moth* has a bronzy ochraceous head and thorax, and grey abdomen. Its legs are white and are banded with dark fuscous irroration and its fore-wings are lanceolate and bronzy ochraceous.

The *caterpillar* is about 4 mm. long with a greenish or yellow head. Its prothorax is broad and is ornamented with two brownish spots which are separated by a greenish band.

The *pupa* is 2.5 mm. long and brown in colour. It is found inside a mine enclosed in a silken cocoon.

Alternative Food Plants.—Not known.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Bird* enemies and *predators* are not known. The pupæ of the insect are parasitised by unidentified chalcid parasites.

Direct Control Measures.—Not known.

References

- Fletcher, T. B. (1920), *Mem. Dep. Agric. India*, Ent. Ser. VI (6), p. 137.
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Grey Weevil (*Mylocerus maculosus* Desb.)

Name and Systematic Position.—The pest belongs to the family curculionidæ, order Coleoptera. Its Latin name is *Mylocerus maculosus* Desb. and its common name is "grey weevil".

Distribution and Status as a Cotton Pest.—The insect is common throughout India and is often abundant on cotton (particularly indigenous varieties) of which it is a regular pest of some importance.

Nature of Damage.—Both the adults and the grubs do damage. The adults eat up leaves; they start their attack from the margin and work their way towards the mid-rib. Buds, flower and young bolls are also attacked.

Grubs feed underground on roots. In the case of grown-up plants they feed on their tender secondary roots but in case of seedlings they damage the tip of the root first and this kills the plant.

Brief Description of the Stages.—The weevil measures $3\frac{1}{4}$ –6 mm. in length and is black with pale grey scaling.

The eggs are ovoid in shape and light yellow in colour.

The grubs are legless, cylindrical, soft and fleshy and measure 8.0 mm. in length when full grown.

The pupæ are creamy white in colour and 4.3–5.7 mm. long.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to the following cultivated crops in addition to cotton:—"bhindi", maize, "bajra", "jowar", "guara", sugarcane, "arhar", mango, "ber", apple, *Pyrus communis*, *P. persica*, *Prunus persica*, *P. communis*, strawberry, pomegranate, "ragi" and Deccan hemp.

In addition to the above, it also feeds on "shisham".

Life-History and Seasonal History.—Polyandry and polygamy are common phenomena among this weevil. The pest winters over as a grub in the top 12" of the soil. The adults become active in April–May when the female starts oviposition. Eggs are ovoid and light yellow in colour and are laid in the soil singly. A single female can lay more than 360 eggs. Oviposition may be continued for as long as 24 days. The eggs hatch in 3–5 days during May–September. The yellowish grub is a legless creature with a soft wrinkled body. It becomes full grown in 1–2½ months when it measures about $\frac{1}{2}$ " in length. Pupation takes place in the soil in a small earthen cell, the pupa being creamy white in colour. The pupal stage occupies about a week during May–October.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: 26 different kinds of birds have been found to feed on this.

Parasites and predators are not known.

Direct Control Measures.—Same as for *M. blandus*. This insect prefers to feed on "arhar". This should be sown earlier than cotton as a trap crop and the insect collected in it destroyed as described under *M. blandus* above.

Important Note.—Of the other species of *Mylocerus*, following are of minor importance to cotton in localities noted against each:—

- (i) *M. discolor* is of wide distribution in India.
- (ii) *M. transmarinus* in the Punjab, United Provinces, Bihar, Bengal, Central Provinces, Bombay and Madras; and
- (iii) *M. sabulosus* in Madras, Bihar, Bengal and United Provinces.

Black Weevils (*Tanymecus* Spp.)

Name and Systematic Position.—These weevils belong to the family Curculionidæ of the order Coleoptera. The Latin names of these weevils are *T. hispidus* Mshl., *T. indicus* Fst., *T. prinseps* Fst. and *T. sciurus* Ol.

Distribution and Status as a Cotton Pest.—Of the 4 species of weevils named above all of which are of minor importance to cotton, *T. indicus* is most commonly distributed in India. It is a sporadic pest of local importance of young wheat, rice and gram and has also been recorded as damaging cotton in the Punjab, Surat (Bombay) and in Madras.

Nature of Damage.—*T. indicus* feeds at night. It cuts off growing points and feeds on leaves and bores holes in them.

Brief Description of the Stages.—*T. indicus* adult measures $4\frac{1}{2}$ – $7\frac{1}{2}$ mm. in length. It is black with brown scaling more or less irrorated with grey.

Alternative Food Plants.—It has been recorded as causing damage to the following cultivated crops in addition to cotton:—wheat, maize, indigo, rice, “jowar”, sannhemp, “patson”, poppy.

In addition to the above it feeds on sunflower.

The other three weevils have been found feeding in addition to cotton on beans, rice, maize, sugarcane, lucerne, “ber”, and “shisham”.

Life-History and Seasonal History.—This has not yet been worked out.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: These weevils have been recorded from the stomach of 15 different species of birds.

Parasites and predators of these weevils are not known.

Direct Control Measures.—Small pieces of red pumpkin if placed between the rows of cotton in the evenings, attract a large number of these beetles which can be collected and destroyed every morning. They can also be entrapped by placing small stacks of weeds at short distances in the rows.

Green Weevil (*Astycus lateralis* F.)

Name and Systematic Position.—The weevil belongs to the family Curculionidæ of the order Coleoptera. Its Latin name is *Astycus lateralis* F. and common name “green weevil”.

Distribution and Status as a Cotton Pest.—The insect is widely distributed in India and is a sporadic pest of minor importance to cotton.

Nature of Damage.—The adults bite holes in the leaves of cotton.

Brief Description of the Stages.—The *adult* is black with pale green scaling which is sparse dorsally but much denser along the sides of the head, thorax and elytra.

Alternative Food Plants.—In addition to cotton the insect has been found on the following cultivated plants:—sugarcane, “bhindi,” “jowar,” “arhar”, guara, “patson”, sannhemp and “ragi”.

In addition to the above it feeds on the following non-cultivated plants also:—shoe flower, *Amaranthus* and Indian coral tree.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—No regular observations have been made on this point but speaking generally the insect thrives best in humid localities with fairly high temperature.

Natural Enemies and Biological Control.—*Bird* enemies, *parasites* and *predators* are not known.

Direct Control Measures.—Same as for *Mylocerus*.

Reference

Ayyar, T. V. R. (1922), *Agric. Res. Inst., Pusa, Bull.*, No. 125.

Grasshopper (*Catantops annexus* Bol.)

Name and Systematic Position.—It belongs to the family Acridiidae, order Orthoptera. Its Latin name is *Catantops annexus* Bol.

Distribution and Status as a Cotton Pest.—This grasshopper occurs throughout South India especially in the Tinnevely and Ramnad Districts of the Madras Presidency.

It is a minor pest of cotton of sporadic occurrence.

Nature of Damage.—Both adults and hoppers feed on leaves, flowers and bolls of cotton.

Brief Description of the Stages.—The head of the *adult* is considerably produced between the filiform antennæ and its hind femora are serrated above and have black markings.

Alternative Food Plants.—It has been recorded as causing damage to the following cultivated crops in addition to cotton:—“jowar” and “bajra”.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—In South India the insect makes its appearance after the North-East monsoon.

Natural Enemies and Biological Control.—*Birds*: Kestral and the jungle owl feed on this grasshopper,

Parasites and predators of this grasshopper are not known.

Direct Control Measures.—These grasshoppers are easily controlled by hand-nets or small bag-nets.

Paddy Grasshopper (*Oxya velox* F.)

Name and Systematic Position.—The insect belongs to the family Acridiidae, order Orthoptera. Its Latin name is *Oxya velox* F. It is commonly known as “paddy grasshopper”.

Distribution and Status as a Cotton Pest.—The insect is found throughout the plains of India. It is really a pest of rice which has been recorded as feeding on cotton leaves in the Madras Presidency.

Nature of Damage.—This pest destroys leaves.

Brief Description of the Stages.—The *adult* is a greenish insect with a lateral yellow stripe. The female is larger than the male.

The *nymphs* are similar to the adults but are smaller in size. Their wing pads appear in the first instar which in the earlier stages overlap the sides of the thorax.

Alternative Food Plants.—The insect is a serious pest of rice and is also known to attack pulses and cotton.

Life-History and Seasonal History.—The insect breeds throughout the year but is found in largest numbers during the rainy season, (August–November). The method of egg-laying depends upon whether the eggs are being laid in dry soil or marshy places: in the former localities they are laid in the usual grasshopper fashion while in marshy situations they are laid among paddy stems and grass clumps about a couple of inches above the water level, the eggs being protected in either case by a gummy frothy liquid which sets to a spongy mass. In some cases eggs were noticed to have been laid in the folds of cotton leaves in a cotton field. The maximum number of eggs laid by a female was 177.

General Climatic Relationships.—It is on the whole a marshy insect feeding on grasses growing in wet situations.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. *Parasites*: The eggs of the pest are parasitised by the following:—(1) Chalcididae: *Tumidiscapus oophagus* Gir., *Anastatus coimbatorensis* Gir. (2) Proctotrypidæ: *Scelio oxyæ* Gir., *Aximopsis*. Adults have been found parasitised by mites and hoppers by a Sarcophagid. *Predators* are not known.

Direct Control Measures.—(1) Egg parasites should be encouraged, (2) eggs should be destroyed, (3) hoppers and adults should be collected in bag-nets.

Reference

Rao, Y. R. (1921), *Rep. Proc. 4th Ent. Meetings, Pusa*, p. 41.

2. SUCKING

Cotton Aphis (*Aphis gossypii* Glov.)

Name and Systematic Position.—The adult belongs to the family Aphididæ, order Rhynchota. Its scientific name is *Aphis gossypii* Glover and its common name is “green aphis”. In vernacular it is known as “tela” and “teliva” in the Punjab, “labi” and “maho” in the United Provinces and Central Provinces, “chopado” and “gerio” in Gujerat, “chikta” in Hyderabad, “asani”, “suku” and “bank tighalu” in South India.

Distribution and Status as a Cotton Pest.—The insect is met with in all cotton-growing tracts in India. In most of the Provinces in India it is of minor importance but in Hyderabad and South India it occasionally does serious damage to Cambodia and other broad-leaved late varieties of cotton.

Nature of Damage.—The insect is present in colonies on the under-side of leaves and on shoots. It sucks plant sap and lowers plant vitality. Young cotton plants suffer much more from its attack than older plants.

This insect produces honey-dew in which sooty mould grows in due course. This sooty mould interferes with the photosynthetic activities of the plant as well as it imparts to the plant a blackened appearance.

Brief Description of the Stages.—The *adult* is yellowish to dark green in colour and measures about 1/20 inch in length.

The nymphs are green to brown in colour.

Alternative Food Plants.—The insect is polyphagous. At Delhi the following sequence of incidence has been observed on different plants in the year:—Cotton from September to February and sometimes up to April; potato from December to March; *capsicum* sp. from September to April; hollyhock from November to March; “kanghi” from December to April; “bhindi” from September to November; brinjal from February to April; water melon from April to June; “tori” from August to September and “sannhemp” from August to September.

In addition to the above the under-mentioned plants are also attacked by this pest:—*Shorea talura*, guava, shoe flower, sacred basil, “chak”, “mako”, teak, *Lantana Euphorbia* sp., *Tridax* sp., *Vernonia* sp., *Capsella* sp., garden balsam and *Cryptostegis grandiflora*.

Life-History and Seasonal History.—This has not yet been worked out in detail.

General Climatic Relationships.—No regular observations have been made on this point but it appears that cloudy and humid conditions are favourable for its multiplication.

Natural Enemies and Biological Control.—*Birds*: Following birds prey upon the insect:—(1) Brown willow warbler (*Phylloscopus tristis*) and (2) rufous fan tail (*Cisticola cixsians*). *Parasites*: Nymphs have been found parasitised by an unidentified chalcid. *Predators*: Following predators feed on the nymphs and adults of this insect:—(1) Coccinellidæ: *Chilomenes sexmaculata* Fab. (each beetle eats 100–200 aphids a day), *Coccinella septempunctata*, *Scymnus* sp.; (2) Chrysopidæ: *Chrysopa* sp.; (3) Syrphidæ: *Syrphus confracter* Wied (this has proved very effective in Bihar), *Sphaerophoria javana* Wied, *Ischiodon scutellaris* Fab., *Syrphus serarius* Wied, *Syrphus balteatus* De Geer, *Leucopis griseola* Fall. (each eats 70–100 nymphs in its life-time) and *Hemibius* sp.

Following predator feeds on the eggs of the pest:—*Leucopis nigricornis*.

Direct Control Measures.—This insect is usually kept under check by its abovenamed enemies. Should it become necessary, however, the attacked plants, particularly in small plots, should be sprayed with tobacco decoction or nicotine soft soap solution.

References

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 Ghulam Ullah (1940), *Ind. Jl. Ent.*, II (1), p. 14.
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Cotton White-fly (*Bemisia tabaci* Genn.)

Name and Systematic Position.—The adult belongs to the family Aleurodidæ, order Rhynchota. Its Latin name is *Bemisia tabaci* Genn. (*B. gossypiperda* M. & L.). Its common name is cotton white-fly and in the Punjab its vernacular name is “tela”.

Distribution and Status as a Cotton Pest.—The insect has been found in the Punjab, Sind, United Provinces and Bihar but it is a pest of the greatest importance in the Punjab only where the areas of its greatest damage are Multan, Montgomery, Jhang, Lyallpur and Sargodha districts:

Nature of Damage.—This insect was recorded for the first time in the Punjab in 1915. During 1922 it was reported attacking cotton in Montgomery district, and since then it has ranked amongst the most destructive cotton pests of the Province.

The pest affects the plants in two ways:—(1) it sucks their sap and lowers their vitality, (2) the honey dew it produces gives rise to sooty mould which interferes with the plant's photosynthetic activities. because of this sooty mould the attacked plants present a blackened appearance. When the infestation is severe the growth of the plant

is arrested, and if the plants are attacked late in the season, their yield is considerably lowered.

Brief Description of the Stages.—The *adult* is a minute insect which measures about 1/25–1/20 inch in length. It has a yellow body which is lightly dusted with waxy powder. Its hind legs are relatively longer than the other legs.

The *eggs* are stalked, sub-elliptical in shape and light yellow when freshly laid, changing to dark brown subsequently.

The *nymphs* are elliptical in shape and light yellow or yellow in colour with greenish yellow mycetoma and crimson eyes.

The *pupæ* are sub-elliptical in shape, light yellow in colour with brownish operculum.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to the following cultivated crops in addition to cotton:—cauliflower, Indian rape, “toria”, turnips, cabbage, potatoes, “sarson”, “bhindi”, melon, guar, tobacco, brinjal, tomatoes, radish, watermelon, cucumbers, gourd, chillies and some more of minor importance.

In addition to the above it feeds on the following uncultivated plants also:—Sow thistle, Cornsow thistle, safflower, prickly chafflower, white goose-foot, red weed, bind weed, railway creeper and hollyhock.

Life-History and Seasonal History.—Eggs are laid singly invariably on the underside of, mostly top and middle, leaves. A female lays a maximum of 119 eggs in captivity and 16 eggs in 24 hours. The duration of the egg stage depends upon the season: in April–September it lasts 3–5 days, in October and November 5–17 days and in December–January 33 days.

Nymphal stage is completed in 9–14 days during April–September and 17–81 days during winter. The pupal stage occupies 2–8 days.

Life-cycle is completed in 14–107 days, shortest duration of the life-cycle being during August.

The most active period for the pest is from April to September, when it is found on cotton. The insect, however, undergoes three phases of migration during the course of a year:

(1) During November when the cotton crop is almost mature, it migrates to rape, cauliflower, turnips, “sarson”, “toria”, potatoes, etc., of the cultivated plants and *Sonchus*, *Euphorbia* and *Convolvulus*, etc., of the weeds. The immature stages are found on these plants throughout winter. The adults emerge from them during February and start multiplication. (2) By the end of March the white-fly migrates from the above named hosts to the spring food plants, namely hollyhock, cucurbits, “bhindi” and ratoon cotton when it sprouts up

during April. The pest multiplies vigorously on these plants and then migrates to (3) new cotton crop as soon as it germinates.

General Climatic Relationships.—Temperature between 33° C. and 37° C. are the most favourable for oviposition, which is inhibited by temperature of 19° C. or below. The white-fly is at its worst in places where the temperature is high and rainfall scanty, e.g., canal colony tracts of the Punjab.

Natural Enemies and Biological Control.—*Birds:* Bird enemies are not known. *Parasites:* The nymphs are parasitised by an unidentified chalcid parasite. This parasite completes its life-cycle in 6-7 days, parasitisation is at its maximum during September when it, on an average, may parasitise 23.6% of the host. *Predators:* Grubs of *Chrysopa* sp. and a *Coccinellid* beetle (*Brumus* sp.) feed on the adults of the white-fly.

Direct Control Measures.—Spraying the infested crop with rosin compound,* in the ratio of 1 : 6, checks the pest effectively. *Desi* (indigenous) cottons should be sprayed in July and American cottons in August. The cost of spraying is about 2 shillings per acre.

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Cotton Jassid (*Empoasca devastans* Dist.)

Name and Systematic Position.—The insect belongs to the family Jassids of the order Rhynchota. Its Latin name is *Empoasca devastans* Dist. and its common names are “cotton jassid” and “cotton leaf-hopper”.

Distribution and Status as a Cotton Pest.—The pest is widely distributed in India. It is a pest of major importance, particularly of American cottons, and is specially serious in the Punjab and Sind.

* Rosin compound is prepared as follows:—Powder 12 lbs. of rosin and place it with 2 lbs. of sodium carbonate in a vessel and add just enough water to cover the mixture. Boil the mixture over a slow fire, continue boiling and keep on adding small quantities of warm water till the liquid has become thin and clear and deep brown or coffee coloured. Total quantity of water required for preparation of rosin compound is about 18 gallons.

Nature of Damage.—The insect is found on “bhindi” and cotton during June–November. It sucks the sap from the underside of the leaves with the result that in “bhindi” the edges of the leaves turn upwards, while in cotton the edges of the leaves turn downwards, the attacked leaves ultimately becoming red and dropping off the plant. The fruiting capacity of the attacked plant is very seriously affected.

The pest does not attack indigenous varieties of cotton; of the American cottons it attacks 289F./K. 25 with greater severity than 4F., L.S.S., and 289F./43 in the Punjab while Parbhani-American in Hyderabad, Buri 107 in Central Provinces and Cambodia in Madras are less susceptible to its attack.

Brief Description of the Stages.—The *adults* are reddish in winter and greenish-yellow in summer. Their front wings have a black spot and there are two black spots on the vertex of the head. They are about $\frac{1}{4}$ inch long.

The *eggs* are elongate and yellowish white. They are laid singly in the veins of the leaves on the underside. The *nymphs* are green and resemble their parents but are wingless.

Alternative Food Plants.—The insect has been recorded as causing damage to the following cultivated crops in addition to cotton:—“bhindi”, potato, brinjal, and French beans.

In addition to the above it feeds on the following uncultivated plants also:—hollyhock, “ban kapas” and “kangi”.

Life-History and Seasonal History.—Mating takes place 2–16 days after emergence and oviposition starts 2–7 days after mating (Punjab). A female can lay a maximum of 29 eggs in its life-time. Eggs hatch out in 4–11 days in the Punjab, 4–7 days in Sind, and 5–15 days in Madras. The nymphs are full grown in 7–21 days in the Punjab, 7–9 days in Sind and 10–14 days in Madras. Adults live for 36–48 days while the unmated individuals have been observed to live for about 3 months.

In places where cotton is grown as a “kharif” crop (e.g., Punjab) the damage by this insect is at its maximum during July–September but in places where cotton is a “rabi” crop (Madras, Mysore and parts of Hyderabad) it does the greatest damage during December–January.

General Climatic Relationships.—These have not been studied.

Natural Enemies and Biological Control.—*Birds*: Bird enemies and *parasites* are not known.

Predators: Spiders (e.g., *Dictyna albida*) and ants (e.g., *Campopnotus*) have been observed feeding on this insect but they do not exercise any check.

Direct Control Measures.—No direct control measures of this pest are known and the only method of checking the ravages of this pest is the production of resistant varieties.

Important Note.—In addition to *E. devastans* the following jassids have also been found damaging cottons in Provinces noted against each:—*E. formosana* Paoli in Madras, *E. punjabensis* Pruthi and *E. kerri* var. *moti* Pruthi in the Punjab and Sind respectively.

E. notata Mall. and *E. gossypii* have been noted by Misra, C. S. (1919) and Burt, B. C. (1916) in Bihar and United Provinces respectively, only once.

E. punjabensis has been observed feeding on the following cultivated plants in addition to cotton:—tobacco, beans, guava, lucerne, “bajra”, potato, carrot, brinjal, tomato, lentil. In addition to these it has also been found feeding on the following uncultivated plants:—*Zinnia*, safflower.

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Mealy-bug (*Pseudococcus virgatus* Ckll.)

Name and Systematic Position.—The insect belongs to the family Coccidae of the order Rhynchota. Its Latin name is *Pseudococcus virgatus* Ckll. and its common name is “mealy-bug”.

Distribution and Status as a Cotton Pest.—The insect is met with as a minor pest of cotton in Madras, Bombay and Bihar.

Nature of Damage.—It desaps the plant.

Brief Description of the Stages.—The *females* are pale yellow to dusty yellow at the period of gestation. A gravid female has two stout caudal threads at anal lobes.

The *eggs* are round and thinly covered with a few white cotton threads.

The *nymphs* are pale yellow, with two stout cretaceous threads at the pygidial end.

Alternative Food Plants.—The following plants have been observed to suffer damage from this pest in addition to cotton:—tomato (cultivated), banyan (adventitious roots), mulberry, *Dracena* sp., *Hibiscus* sp., “khoki”: *Cissus discolor*, sweet violet and *Croton* sp. (Wild.)

Life-History and Seasonal History.—This has not been studied.

General Climatic Relationships.—The nymphs of the insect become abundant after wet weather.

Natural Enemies and Biological Control.—Bird enemies, parasites and predators are not known.

Direct Control Methods.—Spraying with a contact insecticide, cutting and burning of badly infested plants are recommended.

References

Ayyar, T. V. R. (1919), *Agrici. Res. Inst., Pusa, Bull.*, No. 87.

Ayyar, T. V. R. (1937), *Jl. Bomb. Nat. Hist. Soc.*, XXXIX (1), p. 146.

Cotton Mealy-bug (*Pseudococcus corymbatus* Green)

Name and Systematic Position.—The insect belongs to the family Coccidæ, order Rhynchotha.

Distribution and Status as a Cotton Pest.—The insect is met with as a minor pest of cotton in the Punjab, Bihar and Madras.

Nature of Damage.—It desaps the plant and checks its growth; the attacked plant produces a minimum number of bolls.

Brief Description of the Stages.—The female is dark, castaneous, completely covered with sticky cretaceous white ovisac.

The eggs are round, 0.32–0.36 mm. long and 0.15–0.18 mm. broad, chocolate brown in colour.

The nymphs are deep chocolate in colour with their dorsum thinly covered with a whitish meal.

Alternative Food Plants.—It has been found on the following cultivated plants in addition to cotton:—Mango, potato, soybean, *citrus* spp. In addition to these it has been found in the following:—jack fruit, mulberry and *Casuarina*.

General Climatic Relationships.—The nymphs become abundant after wet weather.

Life-History and Seasonal History.—Not known.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. *Parasites*: Three unidentified chalcids parasitise its nymphs and females. It is also parasitized by *Citonides perspica*. *Predators*: *Scymnus nubilans* feeds on the females, while *Diadiplosis indica* (Cecidomyidæ) and *Eublemma quadrilineata* (Noctuidæ) prey upon its nymphs and adults.

Direct Control Measures.—Spraying with contact insecticides is helpful in controlling the pest. Removing and burning the badly infested plants is recommended in cases of serious attack.

Important Note.—*Phenacoccus iceryoides* Green has been recorded in Bengal, Bombay and Madras but it is only in Madras that it has been found as a minor pest of cotton. Other plants on which this insect has been observed are:—*Odina wodier*, *Citrus* sp., *Olibanum cappam*, *Ficus indica*, lablab, “jioli”, rain tree and mango. Larvæ of *Shelgius epius* have been observed to feed on this bug.

“Nim” Scale (*Pulvinaria maxima* Green)

Name and Systematic Position.—The insect belongs to the family Coccidæ of the order Rhynchotha. Its Latin name is *Pulvinaria maxima* Green. It is commonly known as “nim” scale.

Distribution and Status as a Cotton Pest.—The insect is a serious pest of “nim” (*Melia* sp.) and mulberry but only a minor pest of cotton in South India.

Nature of Damage.—When attacked by this insect young plants dry up and the older plants lose their vitality.

Brief Description of the Stages.—The mature *female* measures 8–9 mm. in length and 4–5 mm. breadth, the margins of its body being fringed with fine spines. The *male* is pinkish brown with shining, transparent whitish wings.

The *eggs* are elongate oval, greenish yellow when freshly laid but become darker before hatching.

The *nymphs* when young are light greenish yellow in colour but when 3 weeks old they become yellowish green in colour.

Alternative Food Plants.—In addition to cotton this scale is found on “nim”, mulberry, *Jatropha curcos*, *Sida* sp., grapekul, “ber” and “khoki”.

Life-History and Seasonal History.—Eggs are laid in batches of 650–900 on leaves and shoots. They hatch in 12–14 days. There are 6–7 generations in a year which overlap, a generation being completed in 6½–8 weeks.

General Climatic Relationships.—This scale is found in abundance during the mild cold weather of South India, while during summer it is rather scarce.

Natural Enemies and Biological Control.—*Birds*: Bird enemies of this scale are not known. *Parasites and predators*: This scale is kept in check by the following parasites and predators:—

Parasites: *Anicetus ceylonensis* How. (Encyrtidæ), *Encyrtus flavus* How. (Encyrtidæ), *Aphecus* sp. (Encyrtidæ), *Perisopterosus* sp. (Encyr-

tidæ), *Scutellista cyanea* Mot. (Microgastridæ) and *Megalomum* sp. (Braconidæ) parasitise the nymphs.

Predators: *Scymnus coccivora* Rkm. (Coccinellidæ) and *Eublemma scitula* Ramb. (Noctuidæ) feed on adults and nymphs and the maggots of *Leucopis luteicoruis* Mal. on the eggs of this insect.

Direct Control Measures.—The insect should be sprayed with fish oil rosin soap (7 lbs. in 8 gallons of water).

Reference

Ayyar, T. V. R. (1925), *Mem. Dep. Agric. India*, Ent. Ser. VIII.

Black Scale (*Saissetia nigra* Nietn.)

Name and Systematic Position.—The insect belongs to the family Coccidæ of the order Rhynchota. Its Latin name is *Saissetia nigra* Nietn. It is commonly known as “black scale” and “black bug”.

Distribution and Status as a Cotton Pest.—The insect occurs in Madras, Mysore, Bombay, Bihar and Bengal usually as a minor, rarely as a major pest of cotton.

Nature of Damage.—It desaps the plant which usually dries up and dies.

Brief Description of the Stages.—The *adults* are usually, deep purple black, occasionally dark chestnut in colour.

Alternative Food Plants.—It has been recorded as causing damage to the following cultivated plants in addition to cotton:—“bhindi” *Luffa* sp., coffee, tea, rubber, castor, fig and almond. In addition to these it feeds on the following uncultivated plants also:—Shoe flower, portia, *Hygrophila spinosa*, *Croton* sp., sandalwood, nut meg, *Justicea Morinda*, *Lawsonia alba* and *Capparis sepiaria*.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds:* Bird enemies are not known. *Parasites:* A chalcid wasp *Scutellista cyanea* Mots exercises effective check on this scale. Other parasites recorded from this scale are:—*Anicetus ceylonensis* How. (Encyrtidæ), *Encyrtus barbatus* Tumb. (Encyrtidæ), *Encyrtus Kotinski* Full. (Encyrtidæ), *Anysis saissetiæ* Ashm., *Cocoophagus longilasciatus* How. (Aphelinidæ), *Eucomys lecaniorum* Meyr. (Encyrtidæ). *Predators:* *Eublemma scitula* is a predator on this scale.

Direct Control Measures.—Prompt removal and burning of affected plants check the spread of the pest.

Reference

Lefroy, H. M. (1908-12), *Mcm. Dep. Agric. India*, II (7), p. 111.

Yellow Scale of Cotton (*Cerococcus hibisci* Green)

Name and Systematic Position.—The insect belongs to the family Coccidæ of the order Rhynchota. Its scientific name is *Cerococcus hibisci* Green and common name “yellow scale of cotton”.

Distribution and Status as a Cotton Pest.—The insect occurs in Bombay, Bengal, Gwalior and throughout South India as a very minor pest of cotton.

Nature of Damage.—It sucks plant juice.

Brief Description of the Stages.—The *scale* is golden yellow in colour, Male measures 1 mm. in length, 0.5 mm. in breadth. Female is broadly pyriform, its abdominal segments are narrowed and tapering to the posterior extremity: it is 1.50–2.75 mm. long and 1.25 mm. broad.

Alternative Food Plants.—In addition to cotton the scale has been found feeding on shoe flower, brinjal, *Hibiscus liliflorus*.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Not known.

Direct Control Measures.—The attacked portions of the plant should be cut and burnt.

Reference

Green, E. E. (1908), *Mem. Dep. Agric. India*, Vol. II (2), p. 15.

Tube-making Cercopid (*Machaerota planitiae* Dist.)

Name and Systematic Position.—The insect belongs to the family Cercopidæ of the order Rhynchota. Its Latin name is *Machaerota planitiae* Dist. and common name “tube-making cercopid”.

Distribution and Status as a Cotton Pest.—This is a sporadic major pest of ratoon cotton which has so far been only recorded at Pusa.

Nature of Damage.—The nymphs construct wiry dirty white calcarious tubes in the cotton plants. The attacked plants lose vitality and produce fewer flowers and bolls.

Brief Description of the Stages.—The *egg* is about 1 mm. long and dirty white in colour.

The *nymphs* when young have dark fuscous head and legs and pale yellow to brown abdomen:

Alternative Food Plants.—In addition to cotton this insect has also been found feeding on *Hibiscus panduriformis*.

Life-History and Seasonal History.—The adults are active in cotton during April–October. The females lay eggs singly or in groups of three in the tissue of the plant. They hatch in about a week and the nymphs reach maturity in 34 days during April–May.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Not known.

Direct Control Measures.—Hand picking of the calcareous tubes along with the nymphs is an effective method of dealing with the pest.

Thrips

Name and Systematic Position.—Two different species of thrips *Scirtothrips dorsalis* Hood and *Thrips tabaci* Lind. have been recorded as causing damage to cotton. Both of them belong to the family Thripidae order Thysanoptera. *Thrips tabaci* is commonly known "onion thrips".

Distribution and Status as a Cotton Pest.—Onion thrips is distributed all over India while *S. dorsalis* is reported from Madras and Hyderabad. Of the two *S. dorsalis* is responsible for greater damage to cotton.

Nature of Damage.—Both adults and nymphs do damage. They lacerate tissue and suck up sap, ultimately killing the attacked shoots or leaf.

Brief Description of the Stages.—The *adult* of *S. dorsalis* is a straw coloured insect measuring 1 mm. in length. Most of its abdominal segments are transversely banded with dark brown colour.

The *eggs* are kidney shaped and laid into the tender leaves.

The *nymphs* are pale yellow in colour.

The *adult* of *T. tabaci* is a yellowish brown insect which measures about 1 mm. in length.

The *eggs* are kidney-shaped.

The *nymphs* are similar to the adults but are pale in colour and without wings.

Alternative Food Plants.—In addition to cotton *S. dorsalis* has been found on castor, brinjal, groundnut, chillies, Deccan hemp and on "amaltas" (an uncultivated plant).

T. tabaci has been found in addition to cotton on the following cultivated plants:—Onion, cabbage and the wild plant *A. sativum*.

Life-History and Seasonal History.—The two thrips begin to attack cotton in Madras in November and Hyderabad in August. They lay their eggs in tender leaves. Full grown nymphs descend to the ground for pupation. The whole cycle is completed in 4-5 weeks.

In the Punjab, onion thrips start breeding on onions in spring. Its entire life-cycle is completed in 12-21 days as follows:—egg-stage 5-9; nymphal stage 4-6; prepupal and pupal stages 3-6.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. *Parasites*: Eggs of these thrips are parasitised by *Thripoctenus brui* Vuillet and their nymphs by *Triphleps tantilus*. A mite, *Camspid* sp., also feeds on them.

Direct Control Measures.—Nicotine sulphate when used in the early stages of the crop is very effective against these thrips.

References

- Ayyar, T. V. R. (1932), *Agric. Live-stock India*, II (4), p. 391.
 Ayyar, T. V. R. (1927), *Mem. Dep. Agric. India*, Vol. X.
 Kemy, H. H. (1926), *Ibid.*, Vol. IX (6), p. 187.

C. INSECTS WHICH DESTROY STEM AND BRANCHES

Cotton Stem Borer (*Sphenoptera gossypii* Kerr.)

Name and Systematic Position.—The insect belongs to the family Buprestidæ, order Coleoptera. Its scientific name is *Sphenoptera gossypii* Kerr. and its common name "cotton stem borer".

Distribution and Status as a Cotton Pest.—The insect is widely distributed in India. It is a minor pest of cotton.

Nature of Damage.—The grubs do the damage. They bore in the stem and the attacked plant ultimately withers and dies.

Brief Description of the Stages.—The *adult* is of a dark bronze colour and measures about 8 mm. in length.

The *eggs* are small, greenish, elliptical and flattened; they are laid singly on stem near the soil.

The *grubs* are white with the thorax greatly swollen. When full grown it is about an inch in length.

The *pupæ* are white at first but become dark before emergence.

Alternative Food Plants.—In addition to cotton this insect has also been found boring in "bhindi".

Life-History and Seasonal History.—This has not been studied in detail. The female lays eggs on the bark generally about midway between the base and the crown of the stem. The larva on hatching bores into the stem in which it completes its larval life.

General Climatic Relationships.—These have not been studied in detail but it has been observed that warm and humid climate favours its multiplication.

Natural Enemies and Biological Control.—*Birds*: Bird enemies of this insect are not known. *Parasites*: Its eggs are parasitised by Trichogramatic parasites, its grubs by *Vipio* sp., *Horminæ* sp., *Glyrtomorphia samenus* Cam., *Neocatolaccus indicus* R. & M. and *N. sphenoptera* F. These parasites exercise definite check on this pest.

Direct Control Measures.—All attacked plants, recognisable from the withered condition, should be promptly removed and burnt.

Cotton Stem Weevil (*Pempherulus affinis* Fst.)

Name and Systematic Position.—The adult belongs to the family Curculionidæ, order Coleoptera. Its scientific name is *Pempherus affinis* Fst. and common name "cotton stem weevil".

Distribution and Status as a Cotton Pest.—The insect has been collected from the whole of Madras Presidency, Pusa and Dehra Dun. It is a serious pest of cotton particularly of *Cambodia* varieties, in South India.

Nature of Damage.—The insect attacks cotton when it is about 3 weeks old. The grubs burrow in the stem in which they make spherical burrows, the attacked plants showing characteristic gall-like swellings on the stem. The attacked plant is killed.

The weevil appears to attack all cottons—exotic and indigenous—and no variety, cultivated or wild, has so far been found to be immune to its infestation. Nadam cotton (*G. arb* var. *typicum* forma *indica*) amongst the Asiatic and Bourbon and three Brazilian varieties, viz., Quebradinho, Verdao and Moco, amongst the New World Cottons have, however, proved to be highly resistant.

Brief Description of the Stages.—The *adult* weevil is dark brown in colour with black and whitish markings and is about 3 mm. long.

The *eggs* may be globular, oval, or cylindrical; they are milky white in colour and measure less than $\frac{1}{2}$ mm. in length.

The *grubs* are creamy white in colour. They have a slightly curved body and a distinct head.

The *pupæ* are white at first but become brown before emergence of adults.

Alternative Food Plants.—The insect is polyphagous. It has been recorded as causing damage to "bhindi" and Deccan hemp and to the following uncultivated plants in addition to cotton:—*Hollyhock*, *Triumfetta rhomboidea*, *Sida acuta*, "tandi", *Sida glutinosa*, *Sida spinosa*, *Sida rhomboidea*, jows mallow, "banochra", "ban kapas", "dheras" and *Malvastrum coromandelianum*.

Life-History and Seasonal History.—The insect has three generations during September–March. The females, which can lay up to 30 eggs in their life-time, deposit eggs on the stem. They hatch in 6–10 days. The larvæ are full-grown in 35–57 days. Pupation takes place in the stem in a specially prepared chamber and before turning into pupa in this chamber the grub constructs a passage through the stem to the outside leaving only the bark intact. Pupal stage occupies

9-12 days. The beetle remains in the chamber for 2-5 days before emergence.

The adults live upto 36 days.

General Climatic Relationships.—Warm and moist conditions are favourable for the increase of the pest.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. The following *parasites* have been recorded from the grubs:—*Spathius critolans* Nixon, *Euderus pempheriphia*, *Aphrastomorphia calandrae*, *Eupelmus erozonomus*, *Eupelmella pedatoria*, *Eupelmus* sp., *Entedon pempherides* Ferr., *Dinarmus coimbatorensis* Ferr., *Bruchocida orientalis* Crawf., *Spathius labdacus* Nixon, *Rhaconotus clearnthes* Nixon, *Spathius valueficus* Wlk.

The parasitization of the pest by these parasites may go up to 30%.

In addition to the above a nematode *Geomernus indica* has also been noted to parasitize in certain plants. *Predators*: Not known. *Diseases*: A fungus, not yet identified, has also been found destroying all its stages excepting the egg.

Direct Control Measures.—The best method of control is to deprive the pest of its food: in Madras removal of cotton sticks by 1st August is compulsory by law (The Madras Agricultural Pest and Diseases Act III of 1919 as amended by Act VII of 1925).

References

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 Krishna Ayyar, P. N. (1941), *Second Conf. Sc. Res. Workers on Cotton in India*, I. C. C. C.
 Krishna Ayyar, P. N. and Narayan Swami, S. P. (1940), *Ind. Jl. Ent.*, II (1) p. 79.
 "Cotton Stem Weevil" (1941), *Ind. Farming*, II (ii), pp. 582-583.

Shoot-Weevils

Name and Systematic Position.—Three different species of shoot-weevils, namely *Alcides affaber* Fst., *A. fabricii* F. and *A. leopardus* Ol. have been recorded as damaging cotton. All of them belong to the family Curculionidæ of the order Coleoptera. They are commonly known as "shoot-weevils".

Distribution and Status as a Cotton Pest.—*A. affaber* occurs in the Punjab and throughout South India as a very minor pest of cotton,

A. fabricii has been found in North West-Frontier Province, United Provinces, Bombay, Bihar, Orissa, Central Provinces and Madras. *A. leopardus* occurs as a very minor pest of cotton in Bihar and South Malabar (Madras).

Nature of Damage.—*A. affaber* gnaws chambers in leaf stalks and lays eggs in them. The grub on hatching bores into stalks and stems up to a length of 25 cm.

Brief Description of the Stages.—The *adult* is a dark greyish brown beetle with pale cross bands on the upper wings.

Alternative Food Plants.—In addition to cotton *A. affaber* has been observed to cause injury to “bhindi” and Deccan hemp. *A. fabricii* to gram, rice and maize and *A. leopardus* to “arhar”, sann-hemp, sunflower and dogs tongue.

Life-History and Seasonal History.—Not studied in detail.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Grubs of *A. affaber* are parasitised to a slight extent by *Aphrastobracon alcidiphagus*; *Microbracon* was reared from the grubs of *A. leopardus* at Pusa.

D. INSECTS WHICH DESTROY BUDS AND SHOOTS

Cotton Bud Moth (*Phycita infusella* Meyr.)

Name and Systematic Position.—The adult belongs to the family Pyralidæ, of the order Lepidoptera. Its scientific name is *Phycita infusella* Meyr. and the common name “bud moth”.

Distribution and Status as a Cotton Pest.—The insect is widely distributed in India. Excepting Surat district (of Bombay Presidency) where it is a serious pest, “bud moth” in other places of its occurrence, is a minor pest of cotton. It usually attacks indigenous cottons.

Nature of Damage.—The pest is serious during June and July in the Punjab and during July–October–November in Surat. It feeds under cover of leaves tied together by silken threads. The attacked leaves wither, dry up and drop off the plant. This checks the growth of the attacked plants.

Brief Description of the Stages.—The *adult* moth is greyish-yellow in colour and speckled with fuscous. It measures $\frac{3}{4}$ inch in wing expanse. The hair of its front wings are a faint-yellow with a yellowish-red wavy line, while its hind wings are white with a marginal brown line.

The *eggs* are round. They are laid on the tender leaves of the top shoots of cotton plants.

The full-grown *caterpillar* is $\frac{1}{2}$ – $\frac{3}{5}$ ” long and of a greenish colour with faint brown stripes on the body and with black head and pronotum.

The *pupa* is chocolate brown, with circinate hairs at the tip of the abdomen.

Alternative Food Plants.—In addition to cotton, this pest has been found to feed on Deccan hemp, *Hibiscus sabdariffa* and *Hibiscus* sp. cultivated; “barari khurd”, uncultivated plants.

Life-History and Seasonal History.—The pest passes the winter as a hibernating caterpillar in dried up fallen leaves. The adults appear on the wing in April.

The females lay eggs on young cotton plants in the Punjab and on alternative host plant, “ambadi” grown as a vegetable in the Central Provinces, Bombay, Hyderabad and Madras. The caterpillars hatch from their eggs on or about the 7th day, web the top leaves together by means of silken threads in which they feed. They are full fed after 21 days, then these pupate inside the twisted leaves, the pupæ being enclosed in a silken cocoon. The pupal stage lasts for 11 days.

General Climatic Relationships.—This is not known.

Natural Enemies and Biological Control.—Bird enemies and predators are not known. Following parasites have been reared from its caterpillars at Lyallpur and Pusa respectively:—*Habrobracon kitcheneri* D. & G. and *Microbracon* sp.

Direct Control Measures.—No satisfactory method of control has been devised against this pest so far. Collection and destruction of the withered leaves is the only effective method of control known so far.

Spotted Bollworms (*Earias* Spp.)

Name and Systematic Position.—The adult insects are moths of the family Noctuidæ of the order Lepidoptera. There are two different species the Latin names of which are *Earias fabia* Stoll. and *Earias insulana* Boisd. They are commonly known as “spotted bollworms”. The larvæ of *E. insulana* are also known as “spiny bollworms”.

Distribution and Status as a Cotton Pest.—Both the species are commonly met with throughout the cotton growing tracts in India as major pests of cotton. Of the two, *fabia* occurs as a serious pest of cotton in regions with comparatively greater rainfall while *insulana* is met with in comparatively drier parts such as Sind and the Punjab. In places where the climate is intermediate as in the Delhi Province and South-Eastern Punjab both the species are common.

Nature of Damage.—In the beginning of the cotton season (when the plants are 6–9” high) the caterpillars bore into the top tender portions of the growing shoots—this is called top boring—which wither and droop. Depending upon the locality 8–60% of the crop

may be damaged in this way. When flower-buds and bolls appear (in the Punjab they appear in July–August) the larvæ turn their attention to them, one larva destroying many of these forms in its life-time. Observations in the Punjab, United Provinces, Hyderabad and Madras have shown that the spotted bollworms destroy 1–30% of buds and 1–40% of bolls in any one week during the year. The attacked flower-buds and bolls drop off the plant. Observations (in the Punjab) have shown that up to 75·6% of the flower-buds and 59·4% of the bolls may thus be damaged by this pest. Attacked bolls which do not shed, open prematurely and badly and yield “kapas” (unginned cotton) which is unfit for sale: observations in the Punjab have shown that 34% of the locks are damaged by this pest.

Brief Description of the Stages.—The *moths* of *E. insulana* measure about 1" in the wing expanse and are of grass-green colour with white hind wings: front wings in some specimens may be light green, yellow, brown or greyish brown. The moths of *E. fabia* differ from *E. insulana* moths in having yellowish head, thorax and fore wings: its fore wings have a pea-green, wedge-shaped band running medially from base to the outer margin.

The *eggs* are spherical, bluish-green in colour with parallel longitudinal ridges which project upwards and impart to it a crowned appearance.

The newly hatched *caterpillar* is brownish-white in colour with a dark head and prothoracic shield and measures about 1·3 mm. in length. Tubercles on the second and third thoracic and first abdominal segments become prominent on the fourth day and develop the orange yellow on the following day. When full-fed a larva measures about $\frac{3}{4}$ inch in length. The dorsum of a *fabia* caterpillar is brownish with a white median longitudinal streak while its ventrum is pale yellow or greenish. The *insulana* caterpillar has a dull greenish white body with a number of black marks all over and with orange dots (these orange dots are not so prominent on *fabia* larva) on the prothorax.

The *pupæ* are of a purplish brown colour with a distinct median carina on the thorax, the 5th abdominal segment having a number of prominent points and the last segment being furnished with 3 teeth-like prominences. The pupæ are enclosed in tough silken cocoons of dirty white to light brown colour. The front of the cocoon is closed by two flaps.

Alternative Food Plants.—The spotted bollworms have been recorded as causing damage to “bhindi” and Deccan hemp in addition to cotton. In addition to these cultivated plants they have also been found feeding on “kanghi”, “gulkhera”, “sonchal”, “kucheri”, “vilayati

kanghi", shoe flower, "ban kapas", *H. rugosus*, *H. manihot*, "jangli ambadi", *Abutilon graveolens*, *A. hirtum*, *Malvastrum coromandelinum*, "briar", *Sida cardifolia*, *S. humilis* and "ban ochra". Of these plants "bhindi" is the favoured food of *E. fabia*.

Life-History and Seasonal History.—The bollworms remain active throughout the year. Their population is, however, at its lowest during December–March in the Punjab. They begin to multiply in April–May and they are numerically most abundant during July–September. They mate at night usually between 1 a.m. to 7 a.m., copulation on an average lasting from quarter of an hour to over three hours. The females lay eggs in instalments only at night: *E. insulana* lays mostly between 7 p.m. to 10 p.m. while *E. fabia* lays eggs throughout the night. Each female can lay 400 eggs in the Punjab and Madras and 600 in Gujerat: the average number of eggs per female is comparatively high (432) in Gujerat. The eggs are laid singly on flower-buds, bracts, top tender leaves and leaf buds. The eggs hatch in 60–72 hours in Madras, 2–6 days in Hyderabad, 4–7 days in Gujerat while in the Punjab, the eggs laid during September and October take 3–4 days and those laid towards the end of October and November 7–9 days, to hatch. The larvæ are full-fed in 10–12 days in Madras, 9–16 days in Gujerat, 7–25 days in Hyderabad while in the Punjab they reached maturity in 7–18 days in August–October and in 28–74 days in November–February. The mature larvæ pupate on the plant (during August–October) or on the ground (during November–December) in the Punjab and Sind but in the United Provinces, Gujerat, Hyderabad, Berar and Madras they generally pupate in shed material or in the soil. The pupal stage lasts 7–25 days during August–October and 41–87 days during December–March.

General Climatic Relationships.—The threshold of development of the pest is 13° C. and further development ceased if the different stages were exposed to constant temperature of 40° C. or over. The minimum time taken by the different stages for completion was at 35° C. at a saturation deficiency of 3 mm.

Natural Enemies and Biological Control.—*Birds:* Bird enemies of the pest are not known.

Parasites: The following parasites have been recovered from this insect from the stage noted against each:—

Family	Species	Stage of the host parasitised	Nature of parasitism	Province where recorded
Trichogrammatidæ	<i>Trichogramma evanescens</i> West.	Egg	Endo parasite	Punjab, Madras, Bombay
Braconidæ	<i>Microbracon lefroyi</i> E. & G.	Caterpillar	Ecto parasite	All over India
	<i>M. greenii</i> , Ash.	"	"	Madras
	<i>M. hebetor</i> Say.	"	"	Madras and Delhi
	<i>M. brevicornis</i> Wlk.	"	"	Punjab, U.P. and Hyderabad
	<i>Rhogas testaceous</i> Grav.	"	Endo parasite	Punjab, Bombay, Hyderabad
	<i>Rhogas aligarhensi</i> Quod.	"	"	Madras
	<i>Bassus</i> sp. nov.	"	Ecto parasite	"
	<i>Apanteles</i> sp.	"	Endo parasite	Bombay
	<i>Chelonus</i> sp.	Pupa	"	"
Ichneumonidæ	<i>Melcha nursed</i> Cam.	"	Ecto parasite	Bombay, Gujerat, Punjab, Bombay, Hyderabad, Madras
Chalcididæ	<i>Chalcis tachardæ</i> Cam.	"	Endo parasite	Punjab
	<i>Chalcis responsnator</i> Wlk.	"	"	"
	<i>Chalcis</i> sp.	"	"	"
	<i>Centrochales</i> sp.	"	"	"
Elasmidæ	<i>Elasmus</i> sp.	Caterpillar	Ecto parasite	"
	<i>Elasmus johnstoni</i> Ferri.	"	"	Madras
Tachinidæ	<i>Actia aegyptia</i> Vill.	"	Endo parasite	Punjab, Bombay, Hyderabad
	<i>Actia hylinata</i> Mall.	"	"	Madras
Chloropidæ	<i>Polyodaspis</i>	"	"	"

Of the above-mentioned parasites *Microbracon lefroyi* is claimed to keep the pest in check in certain years.

Predators: In Madras *Eumenes petiolata* has been observed to hunt *E. fabia* caterpillars and stock them in its nest built high up on trees.

Direct Control Measures.—(1) The larvæ and pupæ of the spotted bollworms are parasitised by a number of parasites, the most important of which is *Microbracon lefroyi* D. & G. This parasite is fairly widely distributed in the Punjab, but is most common at Rohtak, where it may parasitise 60% of the pest larvæ during July–September. These parasites should be encouraged.

(2) In the beginning of the cotton season the attacked shoots should be collected regularly and burnt.

(3) When the pest is destroying flower-buds and boll, the plants should be shaken thoroughly by dragging a rope over them. The attacked flower-buds and bolls will be hurled off the plants to the

ground and the bollworms in them should be drowned by immediately watering the treated fields.

(4) After the cotton crop is over, cotton sticks should be removed from the fields by "beheading" them 2 inches below the ground with a "kudali" any time during January–March. The new sprouts that may appear after this operation should be destroyed in April. Wild host plants such as "kanghi" and "kuchri" should also be eradicated during January–April.

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Pink Bollworm (*Platyedra gossypiella* Saund.)

Name and Systematic Position.—The moth belongs to the family Gelechiidæ of the order Lepidoptera. Its scientific name is *Platyedra gossypiella* Saund. and its common name is "pink bollworm".

Distribution and Status as a Cotton Pest.—The insect is widely distributed in the cotton growing tracts in India. It is the most destructive pest of cotton particularly in the United Provinces, Eastern submontane and Central Punjab, North-West Frontier Province, Berar, Hyderabad, Madras and part of Bombay Presidency.

The pink bollworm is indigenous to India and was first described from Bombay early in the 19th century.

Nature of Damage.—The caterpillar causes the shedding of squares and flowers and when the bolls appear, they are attacked and rendered useless. The young caterpillar bores into these forms and the hole through which it makes its entry into them gets healed up with the result that no trace of its being in them is left behind, the pest does the greatest damage during October–November in Northern

India and during December–January in Berar and Hyderabad, when 75–100% of the bolls are damaged. Each boll may have up to 10 caterpillars which feed and destroy seed and lint. Such heavily attacked bolls are either shed or open prematurely (and are known as “mabrum” bolls in Hyderabad) and are not picked. In a boll 25–60% of the locks may be attacked and this results in 20–50% reduction of weight of cotton. The ginning percentage, oil content and spinning qualities of the fibres are also affected. Damage to seeds in the attacked bolls varies from 10–35%. The pest is more destructive to American than indigenous cottons.

Brief Description of the Stages.—The *moth* is a small insect with a wing expanse of 1 inch. It is dark brown in colour with numerous blackish spots which vary in size and intensity. The palpi are long and curved upward and the first segment of each antenna is furnished with 5–6 setæ.

The *eggs* are flattened, elongate, pearly white when freshly laid they become brown on the third day and deep brown before hatching. They are laid singly or in batches of 2–10 mostly on bolls.

The newly hatched *caterpillar* is pale yellow in colour with a dark head and greyish prothoracic shield; it measures .8 mm. in length. When full-fed a caterpillar measures 3/5 inch in length and is of a pinkish (this colouration appears in the 3rd instar) colour with a brownish head and a light brown pronotum.

The *pupa* measures 7 mm. by 2.5 mm. In the beginning it is of a light yellow colour which gradually deepens to orange-yellow, finally to dark brown. Its cremaster is surrounded by 6–8 short setæ.

Alternative Food Plants.—Cotton is its chief food plant, although it may occasionally be found on “umdi” (not in botanical list) and Deccan hemp (*Hibiscus cannabinis*) (cultivated) and “kanghi” (*Abutilon indicum*) and “gulkhera” (*Althea rosea*) (uncultivated) plants during the cotton season. It has also been found feeding on the following uncultivated plants:—“Jangli ambadi” (*H. panduriformis*), musk mallow (*H. abelmoschus*) and *Hibiscus rugosus*. Pink bollworms have also been recorded from the pods of portia (*Thespesia populnea*)—a shade tree.

Life-History and Seasonal History.—The pest passes the winter as a larva in a white cocoon which is found on the soil among debris, in bolls in the fields or more commonly inside double seeds, i.e., the hollowed out seed in which the pest lies is attached to another partly damaged seed, in the store or rarely among lint. A few of these larvæ may pupate as early as the end of March, the adults from them appearing on the wing in the first week of April, but the main rush of pupation occurs after the onset of monsoons, the largest number of adults coming out during July–15th August. The females lay eggs

on leaves, buds, flowers and bolls, but mostly on bolls. Each female is capable of laying 456 eggs in the Punjab, 309 in United Provinces and 375 in Hyderabad. The eggs hatch in 3-7 days in the Punjab and Madras, 2-12 days in Hyderabad, and 4-23 days in the United Provinces. The young caterpillars eat their way into flower buds to feed on developing flowers or into bolls to feed on seed and lint.

The petals of an attacked flower twist characteristically but because of the healing up of its entrance hole, and attacked bolls cannot be differentiated from a healthy one. The larva is full-fed in 8-16 days in the Punjab, 10-29 days in United Provinces and 9-25 days in Hyderabad. It eats its way out through the boll to pupate on the ground among shed leaves, flowers, lint or under a clod. The pupa is enclosed in delicate flimsy cocoon. The pupal stage lasts 6-17 days in the Punjab, 7-15 days in Madras and 7-20 days in Hyderabad and United Provinces.

The caterpillars whose feeding extends upto November enter into hibernation in double, treble and quadruple seeds, but mostly, as mentioned above, in double seeds. Thus the pest has two distinct types of life-cycle, the short life-cycle and the long life-cycle: in Madras, however, long cycle generations have not been observed, the pest keeps on breeding throughout the year. In short life-cycle the larvæ on becoming full-fed pupate immediately at the end of the feeding period and emerge as moths in due course. This kind of life-cycle is completed during April-October. In the case of the long life-cycle, on the other hand, the larvæ enter into a long resting stage (mostly inside double seeds) which may extend over a period of 8-10 (and in some countries upto 30) months before they pupate and emerge as moths. It is in this resting condition that the pest is taken from place to place in the world through commerce. In the Punjab the pest has long life-cycle during November-March.

The short cycle moths live for 14 days in Madras, 30 days in Khandesh, 56 days in the United Provinces and Hyderabad and 29 days in the Punjab. The long cycle moths may live for 31-69 days.

The insect passes through 3-4 life-cycles during August-October in the Punjab, 4-5 during July to end of November in the United Provinces, 9 during April-July in Hyderabad.

General Climatic Relationships.—Detailed ecological studies made in the Punjab showed that if at the time of emergence of long cycle moths favourable temperature, 75-82° F. is prevalent during greater part of the day and suitable relative humidity of 60-80% available, the pink bollworm, multiplies rapidly and becomes abundant.

Observations at Lyallpur have shown that moths live longest at 15° C. It has also been found that development of the various stages

of the pest ceased or was greatly retarded when they were subjected to constant temperatures higher than 30° C. or lower than 10° C.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. *Parasites*: Following parasites have been recorded from this insect from the stages noted against each:—

Family	Species	Stage attacked	Remarks
Anthocoridae	<i>Triphlepus pectinophrae</i>	Egg	The adults were observed to devour a fair number of eggs in the fields (Madras).
Braconidae	<i>Microbracon lefroyi</i> D. & G.	Caterpillar	Parasitises the caterpillars in flowers and sometimes in bolls. This parasite is more commonly met with in the fields than the others. Its behaviour is similar to that of <i>M. kirpatricki</i> in Sudan.
Braconidae	<i>M. gelechidiphagus</i>	"	Identified as <i>A. pectinophora</i> in Madras.
	<i>M. hebator</i>	"	
	<i>Bracon kitchenerii</i>	"	
	<i>Apanteles</i> sp.	"	
Elasimidae	<i>Elasmus johnstoni</i>	"	A mite which parasitises a fair number of caterpillars in seed or locks. But only exposed caterpillars fall a victim to this parasite.
	<i>E. platyedrae</i>	"	
Bethylidae	<i>Bethylid</i> sp.	"	
	<i>Gonizus</i> sp.	"	
Acrina	<i>Pediculoides ventricosus</i> (Newport)	"	
Chalcididae	<i>Chalcid</i> sp.	Pupa	Not identified.
Eulophidae	<i>Eulophid</i> sp.	"	Do.

None of the above-mentioned parasites acts as an effective check on the pest.

Direct Control Measures.—A satisfactory method of controlling this pest by means of insecticides yet remains to be discovered.

The pest hibernates in cotton seed, bolls on stored cotton sticks and "patti" (refuse) in ginneries. The pest in bolls and "patti" should be destroyed by burning this material before May. The cotton seed should be so treated that its germinating capacity is not affected. One way of doing it is to subject the seed to a temperature of 60° C. for 5 minutes in what is known as Simon heater as is done in Egypt and most probably in United Provinces. But this method of killing the pest is very expensive. A far cheaper and equally effective method of killing the pest in cotton seed is to spread the cotton seed in thin layers in the sun for a day in April or May.

In South India, Berar, Hyderabad, Bombay and Deccan where the pest is carried over through larvæ in unginned cotton and

those resting in the soil, the following control measures are suggested:—

- (a) Early ripening varieties should be sown.
- (b) Final picking should be taken as early as possible and the plants removed from the field immediately after the last picking. This will reduce the number of resting caterpillars appreciably.
- (c) Seed cotton should be ginned 8–10 weeks before the monsoon rains set in.
- (d) During the period when there is no cotton crop in the fields, no cotton plants, sprouts of cotton sticks or stumps and alternative host plants should be allowed to exist in the fields. In Madras a close season under Madras Pest Act is being observed for exotic varieties of cotton.

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E. INSECTS WHICH DESTROY FLORAL BUDS AND FLOWERS

Cotton Bud Maggot (*Dasyneura gossypii* Felt)

Name and Systematic Position.—The adult belongs to the family Cecidomyiadae of the order diptera. Its Latin name is *Dasyneura gossypii* Felt and common name “cotton bud maggot”.

Distribution and Status as a Cotton Pest.—The fly has so far been recorded as a sporadic minor pest of cotton in Madras, Mysore, Berar, Bombay and Hyderabad State.

Nature of Damage.—Maggots bore into flower buds and feed on anthers: such buds fall off. In Hyderabad it destroys about 2% of the flower buds in November and December.

Brief Description of the Stages.—The *adult* measures about 0.75 mm. in length. It has yellowish head and yellowish brown mesonotum and abdomen. The *maggots* are orange yellow.

Alternative Food Plants.—Not known.

Life-History and Seasonal History.—This has not been studied in detail. The eggs are laid on cotton buds and its pupæ are found in withered buds.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Not known.

Direct Control Measures.—Collection and destruction of all withered buds is suggested but is hardly practicable on a field scale.

Gram Caterpillar (*Heliothis obsoleta* F.)

Name and Systematic Position.—The adult moth belongs to the family Noctuidæ* of the order Lepidoptera. Its Latin names are *Chloridea obsoleta* F., *Heliothis obsoleta* F. and *Heliothis armigera* F. It is commonly known as “gram caterpillar” or “American bollworm”.

Distribution and Status as a Cotton Pest.—The insect is widely distributed in India. It is a minor pest of cotton but a major pest of gram and “tur” in Central Provinces, however, the damage done to “buri” cotton (an exotic variety) is appreciable.

Nature of Damage.—The caterpillars feed on leaves. They are, however, seriously injurious to the developing cotton seeds. It gets at the seed by biting a hole through the boll.

Brief Description of the Stages.—The *adult* is a stoutly built ochraceous insect. The forewings are marked with greyish wavy lines and black spots of varying sizes on the upper side and a black kidney shaped mark and a black round spot on the underside. The hind wings are white with dark veins and with a broad blackish band along the outer margin.

The eggs are globular in shape and light yellow in colour.

The *full-grown caterpillar* measures about 35 mm. in length. It is generally very variable in colour; more commonly, however, it is pale apple green with a dark mid-dorsal and two yellow lateral stripes.

The *pupa* measures about 25 mm. in length and is found in an earthen cell.

Alternative Food Plants.—The insect is completely polyphagous. It has been recorded as causing damage to the following cultivated

crops in addition to cotton:—gram, “tur”, “moong”, “Urd”, castor, “jowar”, “bhindi”, “bajra”, maize, lucerne, *Citrus* sp., tobacco, rice, wheat, oats, potato, carrot, onions, sann hemp, indigo, “ragi”, linseed, and tomato.

In addition to the above it also feeds on the following uncultivated plants:—sweet pea, safflower, rose, poppy, Indian hemp, “ban bhindi”, *Antirrhinum majus*, “brair” and holyhock.

Life-History and Seasonal History.—The moths become active after dusk. The females lay eggs generally on the lower side of leaves or on gram pods or cotton bolls. Eggs hatch out in 6 days in February and 2–4 days in April–October. The larval stage is completed in 13–19 days and the pupal stage 8–15 days during April–October.

In the Central and South India the insect is continuously brooded but in the North, January and February are passed as hibernating pupæ.

General Climatic Relationships.—This is not known.

Natural Enemies and Biological Control.—Bird enemies are not known.

Parasites: The eggs are parasitised by *Trichogramma minutum* and caterpillars by two Technid parasites namely *Voria ruralis* Meig. and *Ericarcelia kockhiana* and by an unidentified Ichneumonid.

Predators: A Pentatomid bug, *Andrallus spinidens* was found sucking the caterpillars in Madras.

Direct Control Measures.—The control of this pest yet remains to be worked out. Catching caterpillars in bag-nets and dusting the affected crop with sodium fluosilicate and ashes (1 : 8) may prove useful in reducing the damage by this pest.

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F. INSECTS WHICH DESTROY GREEN BOLLS

1. BITING

(*Amorphaidea arcuata* Motsch.)

Name and Systematic Position.—The weevil belongs to the family Curculonidæ, order Coleoptera. Its scientific name is *Amorphaidea arcuata* Motsch.

Distribution and Status as a Cotton Pest.—It has so far been noted in Coimbatore district of Madras Presidency as a minor pest of *Cambodia* cotton.

Nature of Damage.—The grubs feed inside a tender boll and ruin it.

Brief Description of the Stages.—The *adult* is a small chestnut brown weevil.

Alternative Food Plants.—Not known.

Life-History and Seasonal History.—Life-history of this pest is not known. It remains active on cotton during January–July.

General Climatic Relationships, Natural Enemies and Biological Control, and Direct Control Measures have not been studied.

2. SUCKING

Red Cotton Bug (*Dysdercus cingulatus* F.)

Name and Systematic Position.—The insect belongs to the family Pyrrhocoridae of the order Rhynchota. Its scientific name is *Dysdercus cingulatus* F. and common names “red cotton bug” and “cotton stainer”.

Distribution and Status as a Cotton Pest.—This insect is considered as a rather serious pest of cotton in the United Provinces, Bihar, Berar, Bombay, Hyderabad and Madras. It also occurs in the Punjab but is not considered a pest.

Nature of Damage.—Adults and nymphs desap the plant and lower its vitality. They also suck the sap from the bolls which if young remain stunted, open badly and yield worthless cotton. Attacked seeds are rendered worthless for sowing and for oil extraction. Feeding of these bugs, is considered to be responsible for the introduction of bacteria, *Nematospora gossypii* into the bolls which stains the fibre. Nymphs which congregate in freshly opened bolls to suck sap from the seeds, stain the lint with their excreta: they also get crushed and the juices from their bodies also stain and spoil the lint.

Brief Description of the Stages.—The *adult* is about $\frac{1}{2}$ " long with eyes, antennæ, scutellum red and a spot on each forewing and the membrane of each forewing black; a series of white transverse bands along with posterior margin of each thoracic and abdominal sterna anterior collar of pronotum also white.

The *egg* is round and bright yellow.

The *nymph* is red with a central row of black spots succeeded on each side by a row of white spots on the abdomen.

Alternative Food Plants.—It has been recorded as causing damage to the following cultivated plants in addition to cotton: “bhindi” wheat (with developing gram), maize, “bajra” and Deccan hemp.

In addition to the above it also feeds on the following uncultivated plants:—musk mallow, shoe flower, hollyhock, cape goose berry and *Solanum verbacifolium*.

Life-History and Seasonal History.—The eggs are laid in a loose, irregular mass. They hatch in 7 days in warm, moist weather. The nymphs pass through five instars. Nymphal period occupies 49–89 days.

General Climatic Relationships.—Humidity and temperature are the two factors which control the abundance of this insect. During May, June, July and August, due to low humidity and high temperature, younger nymphs and adults are almost absent. During September–October, due to favourable temperature, there is resumption of activity and gradual increase in their numbers.

Natural Enemies and Biological Control.—*Birds*: Following birds have been noted to feed on the pest:—(1) Black headed oriole (*Oriolus melanocephalus*), (2) Indian oriole (*Oriolus kundoo*), (3) common hawk cuckoo (*Hierococeyx varius*), and (4) nut catch (*Sitta ferintalis*).

Parasites: The adults have been observed to be parasitised by a Tachinid fly.

Predators: The common reduvid bug (*Harpactor costalis* Rev.).

Direct Control Measures.—The insect feeds gregariously. It should be shaken in a vessel containing water with a film of kerosene oil on the surface. “Bhindi” should be used as a trap crop. Small quantities of moist cotton in muslin bags kept in the fields will attract bugs which should be destroyed.

Important Note.—*Dysdercus olivaceus* is confined to the Madras Presidency where it appears in January on the cotton plants.

G. INSECTS WHICH DESTROY OPEN BOLLS AND SEEDS

Dusky Cotton Bug (*Oxycarenus laetus* Kby.)

Name and Systematic Position.—The insect belongs to the family Lygaeidae of the order Rhynchota. Its scientific name is *Oxycarenus laetus* Kby. and common name “dusky cotton bug”.

Distribution and Status as a Cotton Pest.—The insect is present throughout India. In the absence of reliable data on the point, the status of dusky cotton bug as a pest of cotton cannot be fixed. The damage to seed, however, cannot be ignored.

Nature of Damage.—Nymphs and adults suck juice from immature seeds which do not ripen, lose colour and remain light in weight. They also stain the lint by getting crushed in it at the time of ginning.

Brief Description of the Stages.—The *adult* is a small insect with head, antennæ, pronotum, scutellum, body beneath and legs piceous. Its anterior femora are distinctly spined beneath.

The eggs are cigar shaped whitish when freshly laid, turn pale later on and before hatching they become pink. Each egg measures 1.1 mm. long and 0.3 mm. broad.

The newly hatched *nymph* is 1/10 inch long with a rostrum which extends beyond abdomen. The rostrum recedes up to the middle of the abdomen after the nymph has fed for sometime; it now becomes of bright orange colour. After the first moult the nymph becomes reddish-brown; its colour darkening after each moult.

Alternative Food Plants.—It has been recorded as causing damage to “bhindi” in addition to cotton. It has also been observed feeding on the following uncultivated plants:—Deccan hemp, musk mellow, hollyhock and “kanghi”.

Life-History and Seasonal History.—This has not been worked out so far. Its life-cycle is completed in 36–50 days during November–January.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—Not known.

Direct Control Measures.—This insect feeds on gregariously in bolls which should be shaken over, or plucked and dropped in a vessel containing water with a film of kerosene oil on surface.

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Rice Moth (*Corcyra cephalonica* Stt.)

Name and Systematic Position.—The moth belongs to the family Pyralidæ of the order Lepidoptera. Its scientific name is *Corcyra cephalonica* Stt. and common name “rice moth”.

Distribution and Status as a Cotton Pest.—The insect occurs commonly in South India, Bombay and Hyderabad; it is present in other parts of India also. It is a very serious pest of rice and observations in Hyderabad have shown that it breeds readily in cotton seed which it destroys in considerable quantities.

Nature of Damage.—Caterpillars destroy cotton seeds in storage. They live in silken shelters which they construct by webbing together small particles and grass. Older caterpillars live under a dense covering and feed enclosed on a silken web spun between the seeds.

Brief Description of the Stages.—The *moth* is uniformly dark grey in colour with greyish ochraceous or light ochraceous forewings. Females are larger than the males, the former measuring 14–24 mm. and the latter 14–18 mm. in the wing expanse.

The *eggs* measure 0.5–0.65 mm. in length and 0.33–0.36 mm. in breadth. They are pearly white when freshly laid but change to dirty yellow before hatching.

The *caterpillars* when young are creamy white in colour with a yellowish-white head, but when full-grown it measures 13–16 mm. in length and is dirty white in colour with a reddish-brown head, yellowish-brown thoracic shield and dark brown anal shield.

The *pupæ* are leathery brown in colour and measure about 7.5–8 mm. in length. They are enclosed in whitish cocoons which are generally covered with particles of its food-material, debris and excrement, etc.

Alternative Food Plants.—It has been recorded as causing damage to the following stored seeds and other substances in addition to cotton seed:—"Cholam", gram, groundnut seed and cake, wheat and wheat bran, rice and rice bran, maize, "arhar", "moong", "tenai", "ragi", cowpeas, gingely cakes, currants and other dried fruits, all forms of cocoa and chocolates and biscuits.

Life-History and Seasonal History.—The insect is active during February–November when all its stages are met with; in the south it breeds throughout the year. Females lay eggs singly on rough surfaces; they are usually laid at night. A female can lay up to 189 eggs. The eggs hatch out in 4–6 days. The larvæ are full-fed in 45–56 days during January to August. The larvæ pupate among gunny bags, etc. The pupal stage occupies 10–14 days. The adults live for 8–18 days.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Birds*: Bird enemies are not known. *Parasites*: Two parasites, a small Braconid, *Microbracon hebetor* Say. and a Chalcid, *Antrocephalus mahensis* Rasi. have been reared from the pest. They are said to exercise check on the pest.

Direct Control Measures.—Before storing, the seed should be well dried. The stores should also be cleaned before seed is stored in them. Occasionally the seed should be sun dried and stores cleaned again. *Fumigation*: When the attack is in progress, the store room containing the seeds should be fumigated with carbon bisulphide at the rate of 8–12 lbs. per 100 cubic feet of space.

H. MISCELLANEOUS

Termites or White Ants

Name and Systematic Position.—The termites belong to the order Isoptera. They are not yet identified and it is not definitely known whether one or more species attack cotton.

Distribution and Status as a Cotton Pest.—They are met with in all cotton growing tracts in India (more commonly in light soils) as minor pests of cotton.

Nature of Damage.—Termites kill cotton seedlings.

Brief Description of the Stages.—As species causing damage to cotton are not yet definitely identified it is not possible to supply information under this head.

Alternative Food Plants.—Termites feed upon wood, paper, fungi, dried animal and vegetable products.

Life-History and Seasonal History.—The life-history of the termites is only known in very broad outline. The eggs deposited by the queen in the royal chamber are removed by the workers through galleries leading away from it and are placed on fungus grown by them. They hatch out in a week or so in summer and give rise to nymphs, which develop into workers and soldiers, it is said, within about six months. These eggs give rise to the reproductive forms as well, these forms reaching maturity in 1-2 years.

In the case of a freshly started colony the king and queen do the foraging for food themselves and hence carry out the work that is later done by the workers.

Natural Enemies and Biological Control.—Not known.

General Climatic Relationships.—Not known.

Direct Control Measures.—The termites are very difficult to deal with and up to the present, no satisfactory way of controlling them has been devised. Timely irrigation is a certain means of keeping them off. Frequent hoeings and interculture are also helpful in warding off an attack. When attack is on a field-scale sanitary fluid or crude oil emulsion at the rate of 2-3 gallons per acre is put in a canvas bag which is suspended in the irrigation channel at the time when the crop is being irrigated.

Mites

Name and Systematic Position.—There are two species, namely *Eriophyes gossypii* and *Tetranychus telarius* which have been observed to damage cotton leaves. *E. gossypii* is a more serious pest than *T. telarius*. These belong to the families Eriophidæ and Tetranychidæ and order Acarina. *E. gossypii* is commonly known as "cotton woolly mite". This mite is discussed below:—

Distribution and Status as a Cotton Pest.—This mite is generally more common on the *herbaceum* variety of cotton in the Surat and Broach districts of Gujerat and Dharwar of the Bombay Presidency. It causes the diseases known locally as "chhasia" in Surat and "badi rog" in Dharwar.

Nature of Damage.—The mite lives under the tissues of the epidermis of the leaf and causes by the irritation thus set up, a growth of dense whitish hairs on both surfaces of a leaf and on the stem

as well. The attacked leaf remains stunted, curls up and becomes hard and crisp. Seriously attacked plants shed their bolls.

Brief Description of the Stages.—The *adults* are worm-like in appearance. The *eggs* are whitish in colour and ovoid in shape.

Alternative Food Plants.—Not known.

Life-History and Seasonal History.—Not known.

General Climatic Relationships.—Not known.

Natural Enemies and Biological Control.—*Bird* enemies and *parasites* are not known. An unidentified Coccinellid beetle has been found preying upon this mite.

Direct Control Measures.—(1) *Spraying*: Spraying the affected plants with lime-sulphur wash prepared with 1 part lime, 2 parts of sulphur and 15 parts of water and diluted 8 times again before spraying, controls the pest effectively. (2) Removal of the first affected leaves checks the further spread of the mite. (3) *Fumigation*: Treatment of cotton seed with mercury perchloride (1 in 500 parts of water) before sowing has a beneficial effect. Some results can be achieved with fumigation of the seed with carbon bisulphide prior to sowing.

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GLOSSARY OF BOTANICAL TERMS USED IN THE TEXT

English or Vernacular (Hindustani) names wherever available are given

*English or Vernacular Name or
Botanical Name (when English or
Vernacular Names are not available)* *Botanical Name*

<i>Abutilon graveolens</i>	..	..	<i>Abutilon graveolens</i>
"Agathi"	..	..	<i>Sesbania grandiflora</i>
Ailanthus	..	..	<i>Ailanthus</i> sp.
"Ak"	..	..	<i>Calotropis</i> sp.
Almond	..	..	<i>Amygdalis communis</i>
"Amaltas"	..	..	<i>Cassia fistula</i>
Amarantus	..	..	<i>Amaranthus</i> sp.
"Ambadi"	..	..	<i>Hibiscus cannabinus</i>
<i>Antirrhinum majus</i>	..	..	<i>Antirrhinum majus</i>
Apple	..	..	<i>Pyrus malus</i>
"Arhar"	..	..	<i>Cajanus indicus</i>
"Arni"	..	..	<i>Clerodendron philomoides</i>
Arrow root	..	..	<i>Maranta arundinacea</i>
Artichoke	..	..	<i>Helianthus tuberosus</i>
Bajra	..	..	<i>Pennisetum typhoideum</i>
Banana	..	..	<i>Musa sapientum</i>
"Ean bhendi"	..	..	<i>Malachra capitata</i>
"Ban kapas"	..	..	<i>Hibiscus vitifolius</i>
"Ban ochra"	..	..	<i>Urena lobata</i>
Banyan tree	..	..	<i>Ficus bengalensis</i>
Banyan tree	..	..	<i>Ficus indica</i>
"Barkanghi"	..	..	<i>Abutilon graveolens</i>
"Batu karaim"	..	..	<i>Chenopodium murale</i>
Bengal gram	..	..	<i>Cicer arietinum</i>
"Ber"	..	..	<i>Ziziphus jujuba</i>
Bersim	..	..	<i>Trifolium alexandrinum</i>
"Bhindi"	..	..	<i>Hibiscus esculentus</i>
"Brari Khurd"	..	..	<i>Malvestrum tricuspidatum</i>
"Brair"	..	..	<i>Sida cordifolia</i>
"Briar, tandi"	..	..	<i>Sida rhombifolia</i>
Brinjal	..	..	<i>Solanum melongena</i>
"Cabbage"	..	..	<i>Brassica oleracea</i>
Cabbage	..	..	<i>B. oleracea cauda rapa</i>
Cape gooseberry	..	..	<i>Physallus peruviana</i>
<i>Capsella</i> sp.	..	..	<i>Capsella</i> sp.
<i>Capparis</i>	..	..	<i>Capparis</i>
<i>Capparus sepiaria</i>	..	..	<i>Capparus sepiaria</i>

<i>English or Vernacular Name or Botanical Name (when English or Vernacular Names are not available)</i>	<i>Botanical Name</i>
Carrot	<i>Daucus carota</i>
Castor	<i>Ricinus communis</i>
Casuarina	<i>Casuarina</i> sp.
Cauliflower	<i>Brassica oleracea cauliflora</i>
Chida grass	<i>Cynodon dactylon</i>
Chillies	<i>Capsicum annuum</i>
Cholam (sorghum)	<i>Andropogon</i>
Chrysanthemum	<i>Chrysanthemum</i>
<i>Cissus discolor</i>	<i>Cissus discolor</i>
Citrus	<i>Citrus</i> sp.
Cluster bean	<i>Cyamopsis soraloides</i>
Clover	<i>Melilotus parvilora</i>
Coffee	<i>Coffea arabica</i>
Colocynth	<i>Citrullus colocynthis</i>
Corchorus	<i>Corchorus</i> sp.
Coriander	<i>Coriandrum sativum</i>
Cornsow thistle	<i>Sonchus arvensis</i>
Cotton	<i>Gossypium</i> sp.
Cow pea	<i>Vigna catjung</i>
Crotons	<i>Croton</i> sp.
<i>Cryptostegia grandiflora</i>	<i>Cryptostegia grandiflora</i>
Cucumber	<i>Cucumis sativus</i>
<i>Cucumo longa</i>	<i>Cucumo longa</i>
<i>Cucurbitacea</i> sp.	<i>Cucurbitacea</i> sp.
Deccan hemp	<i>Hibiscus cannabinus</i>
Deers footbind weed	<i>Convolvulus arvensis</i>
"Dhank"	<i>Butea frondosa</i>
"Dhaincha"	<i>Sesbania aculeata</i>
"Dheras"	<i>Hibiscus ficulneus</i>
Dogs tongue	<i>Cynoglossum lanceolatum</i>
Doorwa grass, Dub grass	<i>Cynodon dactylon</i>
<i>Dracæna</i> sp.	<i>Dracæna</i> sp.
"Drek"	<i>Melia azadirachta</i>
Euphorbia	<i>Euphorbia hirsuta</i>
Euphorbia	<i>E. neresolia</i>
Euphorbia	<i>E. pilulifera</i>
Euphorbia	<i>E. prostrata</i>
<i>Ficus infectoria</i>	<i>Ficus infectoria</i>
Fig	<i>Ficus</i> sp.
French bean	<i>Phaseolus vulgaris</i>
Gardan balsam	<i>Impatiens</i> sp.

<i>English or Vernacular Name or Botanical Name (when English or Vernacular Names are not available)</i>	<i>Botanical Name</i>
Gram	<i>Cicer arietinum</i>
Grape vine	<i>Vitis vinifera</i>
Groundnut	<i>Arachis hypogæa</i>
Gourd	<i>Lagenaria vulgaris</i>
"Guara"	<i>Cyamopsis psoraliodes</i>
Guava	<i>Psidium guava</i>
Gular	<i>Ficus glumerata</i>
"Gulkhara"	<i>Althea rosea</i>
<i>Hibiscus</i> sp.	<i>Hibiscus</i> sp.
<i>Hibiscus liliflorus</i>	<i>Hibiscus liliflorus</i>
<i>Hibiscus rugosus</i>	<i>Hibiscus rugosus</i>
<i>Hibiscus sabdariffa</i>	<i>Hibiscus sabdariffa</i>
Hollyhock	<i>Althea rosea</i>
<i>Hygrophila spinosa</i>	<i>Hygrophila spinosa</i>
Indian coral tree	<i>Erythrina indica</i>
Indian hemp	<i>Cannabis sativa</i>
Indian rape	<i>Brassica campestris</i>
Indigo	<i>Indigofera arrecta</i>
Indigo	<i>I. summatrana</i>
<i>Ipomoea</i> sp.	<i>Ipomoea</i> sp.
Jack fruit	<i>Artocarpus integrifolia</i>
"Jangli ambadi"	<i>Hibiscus panduræformis</i>
"Jangli bhendi"	<i>Hibiscus pungense</i>
Jasminum	<i>Jasminum</i> sp.
"Jatadhari"	<i>Celosia cristata</i>
"Jent"	<i>Sesbania aegyptica</i>
Jews mallow or edible corchorus	<i>Corchorus olitorius</i>
Jews mallow or edible corchorus	<i>Corchorus tridens</i>
"Jowar"	<i>Andropogon sorghum</i>
Justicea	<i>Justicea</i>
Jute	<i>Corchorus capsularis</i>
"Kanghi"	<i>Abutilon indicum</i>
"Kathimbdi"	<i>Cucurbitaceæ</i> sp.
"Khoki"	<i>Acalypha</i>
"Kuchri"	<i>Malvastrum tricuspidatum</i> <i>A. gram</i>
"Lani"	<i>Heliotropium supinum</i>
Lantana	<i>Lantana</i> sp.
Lawsonia	<i>Lawsonia</i> sp.
<i>Lawsonia alba</i>	<i>Lawsonia alba</i>
Lentil	<i>Lens esculenta</i>
Lettuce	<i>Lactuca sativa</i>

*English or Vernacular Name or
Botanical Name (when English or
Vernacular Names are not available)*

Botanical Name

Linseed	..	..	..	<i>Linum usitatissimum</i>
"Lobia"	..	..	..	<i>Dolichos lablab</i>
Lucerne	..	..	..	<i>Medicago sativa</i>
Luffa	..	..	..	<i>Cucurbitaceæ</i> sp.
Maize	..	..	..	<i>Zea mays</i>
"Mako"	..	..	..	<i>Solanum nigrum</i>
<i>Malvastrum coromandelinum</i>	..	..	..	<i>Malvastrum coromandelinum</i>
Mango	..	..	..	<i>Mangifera indica</i>
Marigold	..	..	..	<i>Betavulgaris</i> var. <i>macrorrhiza</i>
Marua millet	..	..	..	<i>Eleusine coracana</i>
Melon	..	..	..	<i>Citrullus vulgaris</i>
Morinda	..	..	..	<i>Morinda</i> sp.
"Moth"	..	..	..	<i>Phaseolus aconitifolius</i>
Mulberry	..	..	..	<i>Morus</i> sp.
"Mung"	..	..	..	<i>Phaseolus mungo</i>
Musk mallow	..	..	..	<i>Hibiscus abelomoschus</i>
Niger seed	..	..	..	<i>Guizotia abyssinica</i>
"Nim"	..	..	..	<i>Melia</i> sp.
Nutmeg shoots	..	..	..	<i>Virola surinamensis</i>
Oats	..	..	..	<i>Avena sativa</i>
Onion	..	..	..	<i>Allium cepa</i>
Opium	..	..	..	<i>Papaver somniferum</i>
"Patsan"	..	..	..	<i>Corchorus capsularis</i>
Pears	..	..	..	<i>Pyrus communis</i>
Peas	..	..	..	<i>Pisum sativum</i>
Portia	..	..	..	<i>Thespesia populnea</i>
Poppy	..	..	..	<i>Pisum sativum</i>
Potato	..	..	..	<i>Solanum tuberosum</i>
<i>Polygonum glabrum</i>	..	..	..	<i>Polygonum glabrum</i>
Pomegranate	..	..	..	<i>Punica granatum</i>
Pumpkin	..	..	..	<i>Cucurbita pepo</i>
Prickly chaff flower	..	..	..	<i>Achyranthes aspers</i>
Radish	..	..	..	<i>Raphanus sativus</i>
"Ragi"	..	..	..	<i>Eleusine coracana</i>
Railway creeper	..	..	..	<i>Ipomia</i> sp.
Red weed	..	..	..	<i>Euphorbia</i> sp.
Rice	..	..	..	<i>Oryza sativa</i>
Rose	..	..	..	<i>Rosa</i> sp.
Rubber	..	..	..	<i>Hevea brasiliensis</i>
Sacred basil	..	..	..	<i>Ocimum sanctum</i>
Sand dune	..	..	..	<i>Glaucia pharnaceoides</i>

<i>English or Vernacular Name or Botanical Name (when English or Vernacular Names are not available)</i>				<i>Botanical Name</i>
Sandal wood	..	..	..	<i>Santalum album</i>
Safflower	..	..	..	<i>Carthamus tinctorius</i>
Sannhemp	..	..	..	<i>Crotalaria juncea</i>
Sarson	..	..	..	<i>Brassica campestris</i>
Saonf	..	..	..	<i>Pimpinella anisum</i>
"Senji"	..	..	..	<i>Melilotus parviflora</i>
Sesamum	..	..	..	<i>Sesamum indica</i>
Shaftal	..	..	..	<i>Trifolium resupinatum</i>
"Shisham"	..	..	..	<i>Dalbergia sissoo</i>
Shoe flower	..	..	..	<i>Hibiscus rosa-sinensis</i>
<i>Shorea talura</i>	..	..	..	<i>Shorea talura</i>
<i>Sida acuta</i>	..	..	..	<i>Sida acuta</i>
<i>Sida cardifolia</i>	..	..	..	<i>Sida cardifolia</i>
<i>Sida glutinosa</i>	..	..	..	<i>Sida glutinosa</i>
<i>S. humilis</i>	..	..	..	<i>S. humilis</i>
<i>Sida rhomboidea</i>	..	..	..	<i>Sida rhomboidea</i>
<i>S. spinosa</i>	..	..	..	<i>S. spinosa</i>
<i>Sida sp.</i>	..	..	..	<i>Sida sp.</i>
Silk cotton tree	..	..	..	<i>Bombax malabaricum</i>
Silver beet	..	..	..	<i>Beta vulgaris</i>
<i>Solanum verbascifolium</i>	..	..	..	<i>Solanum verbascifolium</i>
<i>S. xanthocarpum</i>	..	..	..	<i>S. xanthocarpum</i>
"Sonchal"	..	..	..	<i>Malva parviflora</i>
Sow thistle	..	..	..	<i>Sonchus oleraceus</i>
Soybean	..	..	..	<i>Glycine hispida</i>
Strawberry	..	..	..	<i>Fragaria vesca</i>
Sugar beet	..	..	..	<i>Beta vulgaris</i>
Sugarcane	..	..	..	<i>Saccharum officinarum</i>
Sweet pea	..	..	..	<i>Lathyrus odoratus</i>
Sweet potato	..	..	..	<i>Ipomea batatas</i>
Sweet violet	..	..	..	<i>Viola odorata</i>
Sword bean	..	..	..	<i>Gannalia ensiformis</i>
"Tandi" (see briar)	..	..	..	<i>Sida rhombifolia</i>
Teak	..	..	..	<i>Tectonia grandis</i>
Tea plant	..	..	..	<i>Camellia theifera</i>
"Thoria"	..	..	..	<i>Euphorbia nerefolia</i>
"Til"	..	..	..	<i>Sesamum indicum</i>
"Tenai"	..	..	..	<i>Setaria italica</i>
Tobacco	..	..	..	<i>Nicotiana tabacum</i>
Tomato	..	..	..	<i>Lycopersicum esculentus</i>
"Tori"	..	..	..	<i>Luffa aegyptiaca</i>

English or Vernacular Name or
Botanical Name (when English or
Vernacular Names are not available)

Botanical Name

"Torla"	..	..	..	<i>Brassica napus</i>
Trewia	..	..	..	<i>Trewia</i>
<i>Tridax</i> sp.	..	..	..	<i>Tridax</i> sp.
<i>Triumfetta rhomboidea</i>	..	..	..	<i>Triumfetta rhomboidea</i>
"Tur"	..	..	..	<i>Cajanus indicus</i>
"Turnip"	..	..	..	<i>Brassica</i> var. <i>rapa</i>
<i>Tylophoon asthmatica</i>	..	..	..	<i>Tylophoon asthmatica</i>
Urid	..	..	..	<i>Phaseolus radiatus</i>
"Val" (lobia)	..	..	..	<i>Dolichos lablab</i>
"Vilayati kanghi"	..	..	..	<i>Abutilon hirtum</i>
Water melon	..	..	..	<i>Citrullus vulgaris</i>
Wheat	..	..	..	<i>Triticum vulgare</i>
White goose foot	..	..	..	<i>Chenopodium album</i>

LIST OF INSECT PESTS ON COTTON IN INDIA

A. Cotton Seedlings—

Large Brown Cricket	..	<i>Brachytrypes portentosus</i> Licht.	Ortho.	Gryllidæ
Cricket 'Tid'	..	<i>Gryllus viator</i> Kirby.	..	..
Black headed cricket 'Tid'	..	<i>Gryllulus domesticus</i> Linn.	..	..
Surface Grasshopper or Dusky ground-hopper	..	<i>Chrotogonus</i> Spp. Kirby. (<i>C. sausurei</i> H. in Madras)	..	Acrididæ
Surface Grasshopper	..	<i>Aiolopus tamulus</i> Fb.	..	..
Surface Grasshopper or Tobacco grass-hopper	..	<i>Atractomorpha crenulata</i> Pb.	..	..
Desert Locust	..	<i>Shistocerca gregaria</i> Forsk.	..	..
Dark Brown Weevil	..	<i>Atactogaster finitimus</i> Fst.	Coleo.	Curculionidæ
Grey Weevil	..	<i>Mylocerus blandus</i> Fst.	..	..
Greasy Surface Caterpillar or Cutworm	..	<i>Agrotis flammatra</i> Schiff.	Lepido.	Noctuidæ
Cutworm	..	<i>Euxoa segetum</i> Schiff.	..	..
	..	<i>E. spinifera</i> Hb.	..	..
Lesser Leafworm	..	<i>Laphygma exigua</i> Hb.	..	..
Hairy Caterpillar	..	<i>Anisacta moorei</i> Swinh	..	Arctiadæ

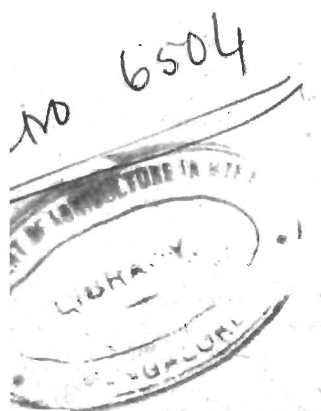
B. Leaves—

(i) Biting:

Leaf Ant	..	<i>Solenopsis geminata</i> Fb.	Hymeno.	Formicidæ
Leaf Roller	..	<i>Sylepta derogata</i> Fb.	Lepido.	Pyralidæ
Green Semilooper	..	<i>Anomis flava</i> Fb. (<i>Cosmophila indica</i> Gn.)	..	Noctuidæ
Semilooper	..	<i>A. fulvida</i> Guen.	..	..
	..	<i>Acontia grællsi</i> Feish	..	..
	..	<i>A. interrupta</i> Guen.	..	..
	..	<i>A. malvæ</i> Esper	..	..
Cotton Semilooper	..	<i>Tarachæ notabilis</i> Wlk.	..	..
Semilooper	..	<i>T. nitidula</i> Fb.	..	..
	..	<i>T. opalinoides</i> Guen.	..	..
	..	<i>T. marmoralis</i> Fab.	..	..
	..	<i>T. biserfa</i>	..	..
Leaf Worm	..	<i>Prodenia litura</i> Fb.	..	..
	..	<i>Mocis (Pelamia) undata</i> Fb.	..	..
	..	<i>Spodotera pecten</i> Gn.	..	..
Bihar Hairy Caterpillar	..	<i>Diactrisla obliqua</i> , Wlk.	..	Arctiadæ
Black Hairy Caterpillar	..	<i>Aloa (Esigmene) lactinea</i> Gram.	..	..
Hairy Caterpillar	..	<i>Euproctis fraterna</i> Mo.	..	Lymantriadæ
	..	<i>E. lunata</i> Wlk.	..	..
	..	<i>E. varians</i> Wlk.	..	..
	..	<i>Porthesia xanthorrhoea</i> Koll.	..	..
Leaf Minen	..	<i>Lithocolletis triarcha</i> Meyr.	..	Gracillaridæ

Leaf perforator	.. <i>Bucculatrix loxophila</i> Meyr.	..	Lyonectidæ
White Weevil	.. <i>Mylocerus-II-pustulatus</i> Var <i>maculosus</i> Desh.	Coleo.	Curculionidæ
Weevil	.. <i>M. discolor</i>	..	..
	<i>M. transmarinus</i> Hbst.	..	..
	<i>M. sabulosus</i> Mshll.	..	..
Black Weevil	.. <i>Tanymecus indicus</i> Fst.	..	..
	<i>T. princeps</i> Fst.	..	..
	<i>T. hispidus</i> Mshll.	..	..
	<i>T. sciurus</i> Oliv.	..	..
Green Weevil	.. <i>Astycus lateralis</i> Fb.	..	..
Desert Locust	.. <i>Schistocerca gregaria</i> Forsk.	Ortho.	Acrididæ
Black Spotted Grass-hopper	<i>Cyrtacanthacris ranacea</i> Stoll.	..	..
Grasshopper	.. <i>Acrida exaltata</i>	..	..
(ii) <i>Sucking:</i>			
Cotton Aphis	.. <i>Aphis gossypii</i> Glover	Rhynchota	Aphididæ
Cotton White Fly	.. <i>Bemisia tabaci</i> Guen. (<i>gossypipetra</i> M. and L.)	..	Aleurodidæ
Jassid or Leaf-hopper	.. <i>Empoasca devastans</i> Dist.	Rhynchota	Jassidæ
	<i>E. formosana</i> Paoli	..	..
	<i>E. punjabensis</i> Pruthi	..	..
	<i>E. kerr</i> var <i>motti</i> Pruthi	..	..
	<i>E. notata</i> Mell	..	..
	<i>E. gossypii</i>	..	..
Mealy Bug	.. <i>Pseudo-coccus Virgatus</i> Ckll.	..	Coccidæ
	<i>P. corymbatus</i> Green	..	..
	<i>Phenococcus hirsutus</i> Green	..	..
Nim (Melia) Scale	.. <i>Pulvinaria maxima</i> Green	..	..
Black Scale or Black Bug	.. <i>Saisseta nigra</i> Nietm.	..	..
Yellow Scale or Cotton	<i>Cerococcus hibisci</i> Green	..	..
Cotton Scale	.. <i>Chionaspis</i> Sp.	..	..
Tube-making Ceropid	<i>Machaerota planitia</i> Eurybrachus <i>tomebtosa</i> Fb.	..	Cercopidæ
Capsid Bug	.. <i>Ragnus importunatus</i> D.	..	Fulgoridæ
Thrip	.. <i>Scirtothrips dorsalis</i> Hd.	Thysano.	Capsidæ
	<i>Thrips tabaci</i> L.	..	..
C. Stems and Branches—			
Stem Borer	.. <i>Sphenoptera gossypii</i> Kerr.	Coleo.	Buprestidæ
Stem Weevil	.. <i>Pempheres affinis</i> Fst.	..	Curculionidæ
Shoot Weevil	.. <i>Alcides affaber</i> Fst.	..	..
	<i>A. leopardus</i> Oliv.	..	..
	<i>A. fabricii</i> Fb.	..	..
Black Scale or Black Bug	<i>Saisseta nigra</i> Nietm.	Rhynchota	Coccidæ
Yellow Scale of Cotton	<i>Cerococcus hibisci</i> Green	..	..
D. Buds and Shoots—			
Bud Moth	.. <i>Phycita infusella</i> Meyr.	Lepido.	Pyralidæ
Spotted Bollworm	.. <i>Earias fabia</i> Stoll	..	Noctuidæ

Spotted or Spiny Bollworm	..	<i>E. insulana</i> Boisfd.	..	Pyrilidæ
Pink Bollworm	..	<i>Platyedra gossypiella</i> Saund.	..	Gelechiidæ
E. Floral Buds (Squares) and Flowers—				
Floral Bud Maggot	..	<i>Dasyneura gossypii</i> Felt.	Diptera	Cecidomyidæ
Spotted Bollworm	..	<i>Earias fabia</i> Stoll.	Depido.	Noctuidæ
Spotted or Spiny Bollworm	..	<i>E. insulana</i> Boisd.	..	..
Gram Caterpillar or American Bollworm	..	<i>Heliothis (Chloridæ) obsoleta</i> Fb.	..	..
Pink Bollworm	..	<i>Platyedra gossypiella</i> Saund.	..	Gelechiidæ
Blister Beetle	..	<i>Zonabris pustulata</i> Thnb.	Coleo.	Meloidæ
F. Green Bolls—				
(i) <i>Biting:</i>				
Pink Bollworm	..	<i>Platyedra gossypiella</i> Saund.	Lepido.	Gelechiidæ
Spotted Bollworm	..	<i>Earias fabia</i> Stoll.	..	Noctuidæ
Spotted or Spiny Bollworm	..	<i>E. insulana</i> Boisd.	..	..
Gram Caterpillar or American Bollworm	..	<i>Heliothis obsoleta</i> Fb.	..	..
Red Bollworm	..	<i>Rabla frontalis</i>	..	..
Grasshopper	..	<i>Catantops</i> Sp.	Ortho.	Acridiidæ
Black beetle	..	<i>Amorphoidæ arcuata</i> M.	Coleo.	Curculionidæ
(ii) <i>Sucking:</i>				
Red Cotton Bug or Stainer	..	<i>Dysdercus cingulatus</i> Fb.	Rhynchota	Pyrrhocoridæ
Stainer	..	<i>D. olivaceus</i>	..	..
Green Bug	..	<i>Nezara viridula</i> L.	..	Pentatomidæ
Capsid Bug	..	<i>Ragnus morosus</i> Ball.	..	Capsidæ
	..	<i>R. flavomaculatus</i> Ball.	..	..
	..	<i>Serinatha augur</i> Fb.	..	Coreidæ
	..	<i>Clavigralla horrens</i> Dohrn.	..	..
	..	<i>Lygwys pandurus</i> Scop.	..	..
	..	<i>L. hospes</i> Fb.	..	..
G. Open Bolls—				
Dusky Cotton Bug	..	<i>Oxycarenus letus</i> Kby.	..	Lygæidæ
H. Roots—				
White Ants	..	<i>Termites</i>	Isoptera	..
White Weevil	..	<i>Mylloceris maculosus</i>	Coleo.	Curculionidæ
I. Seeds—				
Dusky Cotton Bug	..	<i>Oxycarenus letus</i> Kby.	Rhynchota	Lygæidæ
	..	<i>Alphitobius piceus</i> Ol.	Coleo.	..
Rice Mealworm	..	<i>Coreyra cephalonica</i> Saund	Lepido.	Pyrilidæ



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